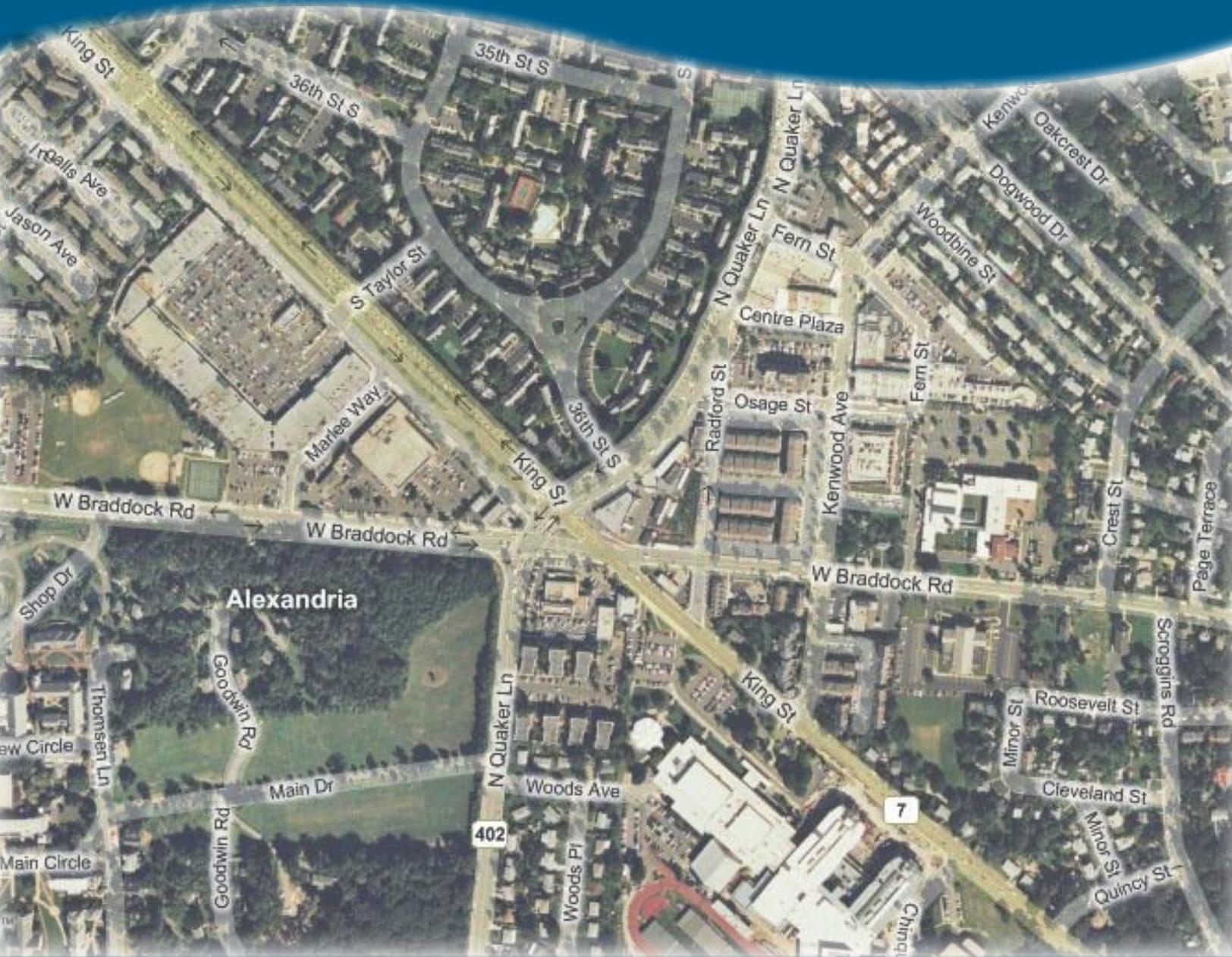




# ROUTE 7 SPOT IMPROVEMENT STUDY BRADDOCK ROAD - KING STREET - QUAKER LANE

APRIL 2010



*Vanasse Hangen Brustlin, Inc.*

*8300 Boone Boulevard, Suite 700  
Vienna, Virginia 22182*

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## **Executive Summary**

The purpose of this study was to identify and evaluate potential multimodal transportation improvements along a portion of Route 7 (King Street) in western Alexandria. A focus area of this study was on the intersections of Braddock Road and Quaker Lane with Route 7, as well as other nearby intersections and roadways, including Quaker Lane and Braddock Road. In addition to congested traffic conditions, provision of safe and efficient multimodal access to nearby properties and neighborhoods was a catalyst for this study.

The study included operational analyses at nine (9) signalized intersections and a safety review of a tenth intersection. The King Street (Route 7)/Braddock Road/Quaker Lane intersection is actually a collection of three separate, but closely spaced, signalized intersections operated by a single traffic signal controller. These three signals comprise a critical junction for regional vehicular traffic along the King Street (Route 7), Braddock Road, and Quaker Lane roadway corridors. To better understand existing intersection operations, detailed traffic analyses were performed at multiple intersections along the King Street (Route 7), Braddock Road, and Quaker Lane corridors.

This document summarizes traffic operations at a total of nine intersections within the project study area, under both existing and future conditions. Additionally, this study evaluated operation of the primary roadway corridors and reviewed the safety-related performance of a number of critical locations in proximity to the King Street (Route 7)/Braddock Road/Quaker Lane intersection. With the assistance of the City of Alexandria Transportation & Environmental Services Department, a number of alternative design concepts were developed to improve the overall operation of the King Street (Route 7)/Braddock Road/Quaker Lane intersection and adjacent roadway facilities. Evaluation of the operational benefits associated with each alternative was completed through detailed analysis of the individual intersections and micro-simulation of the inter-dependent signal operations. The operational attributes of each scenario were quantified according to a variety of performance-based measures-of-effectiveness and the relative benefits and disadvantages of each alternative are documented in this study. The following is a list of the major infrastructure improvement proposals developed for the King Street (Route 7)/Braddock Road/Quaker Lane intersection:

- Construction of additional left-turn lanes at targeted locations within the Braddock Road/King Street/Quaker Lane intersections to provide dual left-turn capacity at locations currently only providing single left-turn lanes;
- Closure of the segment of Braddock Road between Quaker Lane and King Street;
- Closure of a segment of Quaker Lane to the north of King Street and diversion of existing traffic onto Radford Street;
- Reconfiguration of Quaker Lane and Radford Street, to the north of King Street, to operate as a pair of one-way streets, in opposite directions;
- Construction of a roundabout design, entirely replacing the existing signalized intersections; and
- Construction of a grade-separated interchange design, placing Braddock Road below Quaker Lane and King Street, with ramp access between the grade-separated roadways.

The capacity analysis and micro-simulation results suggest that not all of the proposals are capable of providing operational improvement within the study area. Additionally, feedback from City of Alexandria transportation staff, and members of the community, indicated little support for the improvement concepts that involved significant property impacts and high capital costs. This evaluation suggested that the alternatives primarily involving left-turn lane improvements, within the closely spaced existing intersections, would likely provide noticeable improvement over the long-term, without major impacts to private property.

This intersection study also determined that a variety of short-term operational and safety improvement measures can be immediately accomplished within the study area for relatively low cost. These measures primarily consist of properly maintaining vegetation, installing signage, and modifying pavement markings, which can provide noticeable operational and/or safety-related benefits at targeted locations.

Additional long-term physical and geometric roadway improvements were developed for the service road along King Street, west of Quaker Lane. These long-term improvement measures are intended to reduce use of the service road by cut-through traffic, while maintaining and simplifying access to the existing commercial properties along King Street. These measures include the potential closure of part(s) of the existing service road and construction of a transit center located adjacent to the King Street/Taylor Street intersection which can be implemented with or without proposed improvements.

This study also evaluated a road-diet design for Quaker Lane between Braddock Road and Duke Street, which would reduce the existing cross-section of Quaker Lane from four lanes (two in each direction) to two lanes, with a center two-way left turn lane. This configuration provides a number of traffic-calming benefits to the communities located within this area. However, analysis results provided in this study demonstrate that these measures are likely to result in significant queuing and congestion along Quaker Lane, possibly affecting the Duke Street and Braddock Road corridors that bookend the corridor.

Finally, preliminary order-of-magnitude costs for the lower impact and cost alternatives were developed. These preliminary cost estimates are intended to inform the City of Alexandria during the process selection of the recommended design alternative.

**Order Of Magnitude Cost Estimates**

| Costs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                          | Estimated Cost (\$)                                    |
|--------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|--------------------------------------------------------|
| <p><b>Conceptual Alternative 1</b><br/>                     Add a second left-turn lane at four locations within the intersection of King Street / Braddock Road / Quaker Lane, including eastbound King Street at Braddock Road and Quaker Lane, northbound Quaker Lane at King Street, and westbound Braddock Road at Quaker Lane. These improvements would also include the realignment of Braddock Road at King Street to accommodate the addition of the left turn lanes. The improvements would increase the left-turn capacity for these heavy movements. The service road access onto Quaker Lane would be closed.</p> | <p style="text-align: center;"><b>\$ 1,900,000</b></p> |
| <p><b>Conceptual Alternative 2</b><br/>                     Close the segment of Braddock Road between King Street and Quaker Lane; affected traffic would be rerouted to King Street and Quaker Lane. Additional left-turn lanes would be provided for King Street traffic and the service road access onto Quaker Lane would be closed. This reconfiguration would simplify the operations at the signal.</p>                                                                                                                                                                                                                | <p style="text-align: center;"><b>\$ 1,950,000</b></p> |

| Costs                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                                               | Estimated Cost (\$) |
|-----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|---------------------|
| <p style="text-align: center;"><b>Transit Center</b></p> <p>Construct a transit center on the service road in front of the Bradlee Shopping Center. This would entail closing a segment of the service road to through traffic. The improvements would simplify the traffic operations of the intersection of the service road at the signal on King Street by reducing the number of movements at the intersection.</p>                                                                                                                            | <p>\$ 500,000</p>   |
| <p style="text-align: center;"><b>Road Diet along Quaker Lane</b></p> <p>The cross-section of Quaker Lane would be reconfigured from a four-lane to a three-lane cross-section, where the center lane would be a two-way left-turn lane. The signalized intersections would not be modified, other than at Seminary Road / Janneys Lane where the number of through lanes would decrease from four to two lanes. This improvement would help reduce travel speeds along Quaker Lane, and provide left-turn lanes into residential side streets.</p> | <p>\$ 155,000</p>   |
| <p style="text-align: center;"><b>Short Term Improvements</b></p> <p>Safety improvements to the intersection of King Street / Dearing Street / Wakefield Street, and wayfinding improvements at the intersection of King Street / Braddock Road / Quaker Lane. Bus Shelters and pullout areas could also be throughout the study area to encourage more riders.</p>                                                                                                                                                                                 | <p>\$ 35,000</p>    |

Note: Either Alternative 1 or 2 would be selected.  
 The costs presented above represent order-of-magnitude costs only.

## **1. Introduction**

Vanasse Hangen Brustlin, Inc. (VHB) has prepared this report on the Route 7 Spot Improvements Study (Braddock Road, King Street and Quaker Lane Traffic Study) to document an evaluation of potential transportation improvements to the study area intersections that are located within the City of Alexandria, Virginia. The complex intersection of King Street, Braddock Road and Quaker Lane is a collection of three closely-spaced signalized intersections: King Street at Quaker Lane; King Street at Braddock Road; and Braddock Road at Quaker Lane. All three intersections are spaced approximately 200-250 feet apart and these intersections are located right at the border of the Arlington County and the City of Alexandria jurisdictional limits.

These intersections form a critical junction serving several important routes through the City of Alexandria. Due to heavy demands on all three roadways during the weekday morning and evening peak periods of commuter traffic, congestion is often observed at these intersections. The following operational observations were made during the course of this evaluation:

- Heavy travel demand, high vehicle speeds especially along Quaker Lane, and the complex intersection configuration are major contributors to the congestion observed at these intersections;
- Congested traffic operations on the primary roads through the study area are exacerbated by traffic activity associated with adjacent shopping centers and land uses; and
- This congestion can hamper the mobility of non-motorized and bus traffic, contributing to degradation of transit service within the study area.

It should also be noted that several transit bus stops located within the study area do not provide desirable facilities, such as a bus stop turn bay or a passenger shelter. The lack of such facilities would result in rider's discomfort (lack of a shelter for inclement weather) or disrupt traffic flows as buses do not have a pullout area.

The study area consists of an approximately one-and-a-half mile (1.5 mile) section of Quaker Lane, bounded by King Street and Braddock Road to the north and Duke Street to the south, in the City of Alexandria. Additionally, along the Braddock Road and King Street corridors study limits are from approximately 0.2 miles west of the Braddock Road / Quaker Lane intersection to 0.2 miles east of the King Street / Quaker Lane intersection. The study area is illustrated in **Figure 1** with study intersections circled.

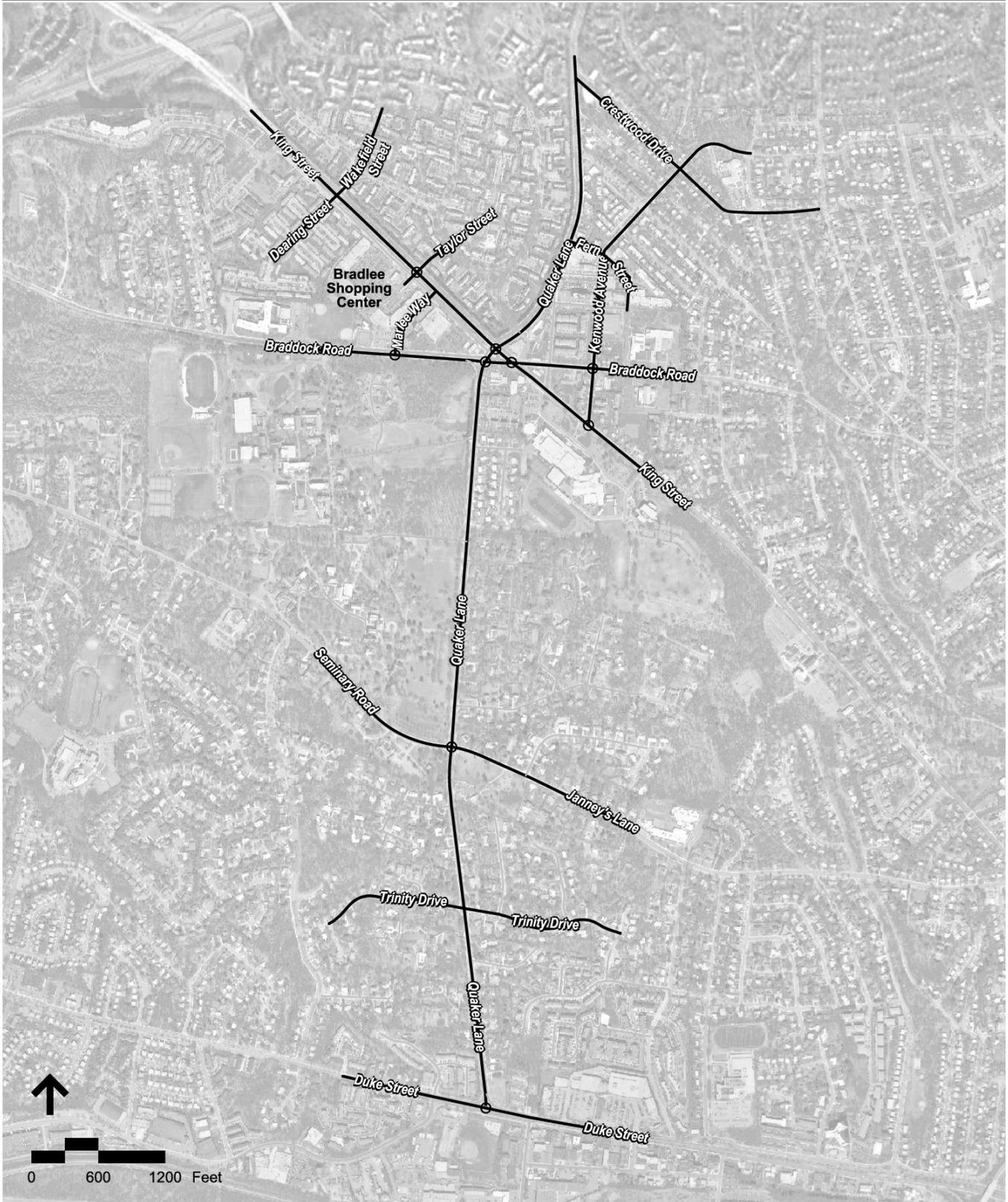


Figure 1: Study Area

## **2. Study Methodology**

The traffic assessment was conducted in three stages. The first stage involved an assessment of existing traffic conditions within the project area, including an inventory of existing roadway geometry, observations of traffic flow, peak period traffic counts, and a review of crash data and other traffic safety parameters in the study area. This study assessed three peak hour conditions: weekday AM peak hour, weekday PM peak hour and a Saturday peak hour.

The second stage of the study involved development and evaluation of potential improvement alternatives for the study area. Travel demand forecasts for each of the alternatives were assessed and future traffic demands, due to projected regional traffic growth and area development, were assigned to the study area roadways. The year 2020 was selected as the design year for all future conditions analysis. The traffic analysis conducted in this second stage identified the operational benefits or drawbacks of each potential improvement alternative. A two-tiered analysis approach, involving the use of a discrete, location-based analysis tool and then micro-simulation analysis, was used to evaluate operations.

The third stage of the study had involved development of order-of-magnitude cost estimates for each improvement alternative.

## **3. Existing Conditions**

### **3.1. Roadway Characteristics**

Within the study area, several significant roadways comprise the roadway system. Roadway characteristics and land uses along these major roadways are described as follows.

#### ***King Street***

King Street, also known as Route 7, runs in the east-west direction, and is a divided four-lane facility west of Quaker Lane with a posted speed limit of 35 mph. To the east of Quaker Lane, the roadway is an undivided four-lane facility, having a posted speed limit of 25 mph. King Street connects to I-395 to the west and extends eastwards to Route 1, Washington Street and Old Town Alexandria. Within the study area along segments west of the intersection with Quaker Lane, King Street serves access to shopping centers and residential areas with a two-way service road located parallel to King Street. Roadway

segments east of the intersection with Quaker Lane Street serve as access to residential areas and schools without a parallel service road.

***Quaker Lane***

North Quaker Lane, which runs in the north-south direction from Duke Street to Shirlington Road, is an undivided four-lane facility south of Braddock Road and divided four-lane facility north of Braddock Road with posted speed limits varying between 25 to 35 mph. The posted speed limit is 35 mph along North Quaker Lane northbound and 25 mph along southbound, between Trinity Drive and Duke Street. The posted speed limit is 35 mph along North Quaker Lane, north of Trinity Drive except for the northbound direction, which is 25 mph as it approaches the intersections with King Street and Braddock Road. No parking is allowed along this roadway, which is also designated as a snow emergency route. Within the study area, Quaker Lane intersects with a number of major roadways, including Duke Street, Seminary Road / Janneys Lane, Braddock Road, and King Street. To the north of the study area, Quaker Lane connects to I-395 and Shirlington. Within the study area along segments south of the intersection with King Street, Quaker Lane mainly serves access to residential areas. Roadway segments north of the intersection with King Street serve a access to commercial developments and residential areas.

***Braddock Road***

Braddock Road, which runs in the east-west direction, is a divided four-lane facility west of Quaker Lane, with a posted speed limit of 35 mph, and has an on-street bike route. To the east of Quaker Lane, Braddock Road is an undivided two-lane facility having a posted speed limit of 25 mph. Within the study area, Braddock Road mainly serves as access to commercial developments and residential areas.

***Duke Street***

Duke Street, which runs in the east-west direction, is an undivided four-lane facility with two through lanes and auxiliary turn lanes for each approach. The posted speed limit is 35 mph and no parking is allowed. Duke Street connects to I-395 towards the west and extends towards the east to Route 1, Washington Street, and Old Town. Within the study area, Duke Street mainly serves as access to commercial developments.

***Seminary Road and Janneys Lane***

Seminary Road and Janneys Lane mainly serve the residential area providing connection to King Street (Route 7) to the east, and I-395 to the west. Seminary Road runs westward from North Quaker Lane and

is an undivided four-lane facility. Janneys Lane is an undivided two-lane facility and runs eastward from North Quaker Lane. Both roadways have a posted speed limit of 25 mph.

### 3.2. Vehicular Flows

Within the study limits, nine major signalized intersections were identified and turning movement counts at these signalized intersections were collected. The following is a list of the major signalized intersections within the study area that have been analyzed:

1. King Street / Taylor Street
2. King Street / Quaker Lane
3. King Street / Braddock Road
4. King Street / Kenwood Avenue
5. Braddock Road / Marlee Way
6. Braddock Road / Quaker Lane
7. Braddock Road / Kenwood Avenue
8. Quaker Lane / Seminary Road / Janneys Lane
9. Quaker Lane / Duke Street

Among these study intersections, this evaluation provides a particular focus on the three intersections that comprise the Braddock Road, King Street, Quaker Lane junction: King Street at Quaker Lane, King Street at Braddock Road, and Braddock Road at Quaker Lane. A single traffic signal controller operates these three closely spaced intersections.

Existing intersection lane configurations are shown in **Figure 2**. Existing peak hour traffic volumes at each study intersection are summarized in **Figure 3**. Turning movement counts were collected in April of 2008 from 7 AM to 9 AM and from 4 PM to 6 PM during the weekday condition. For Saturday conditions, counts were collected from 12 PM to 2 PM. The peak hour generally fell between 7:30 AM to 8:30 AM and 5:00 PM to 6:00 PM during the weekday. During Saturday, peak hour was between 1:00 PM and 2:00 PM. Tables summarizing the specific turning movement volumes are also included in the Appendix.

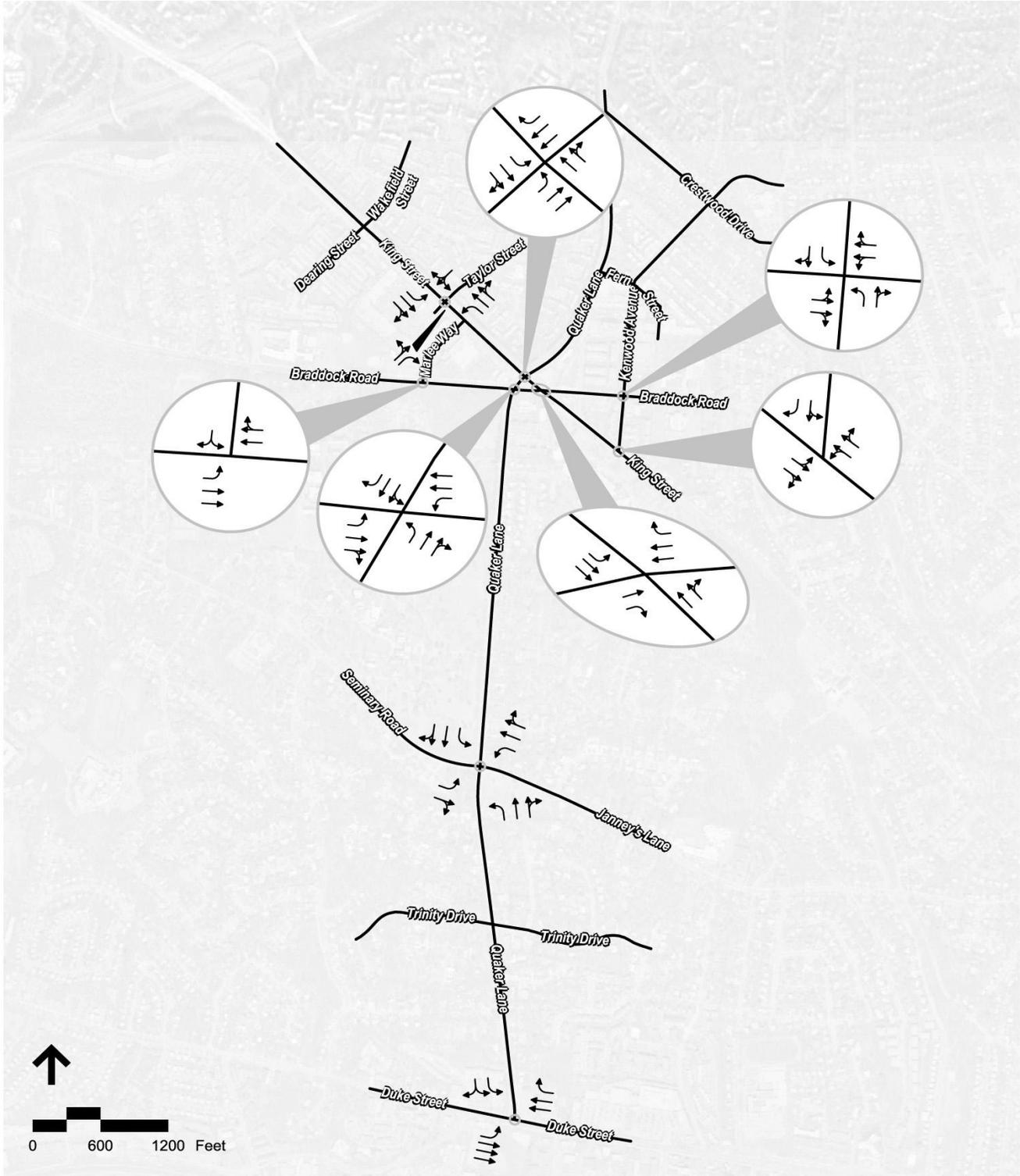


Figure 2: Existing Lane Configurations

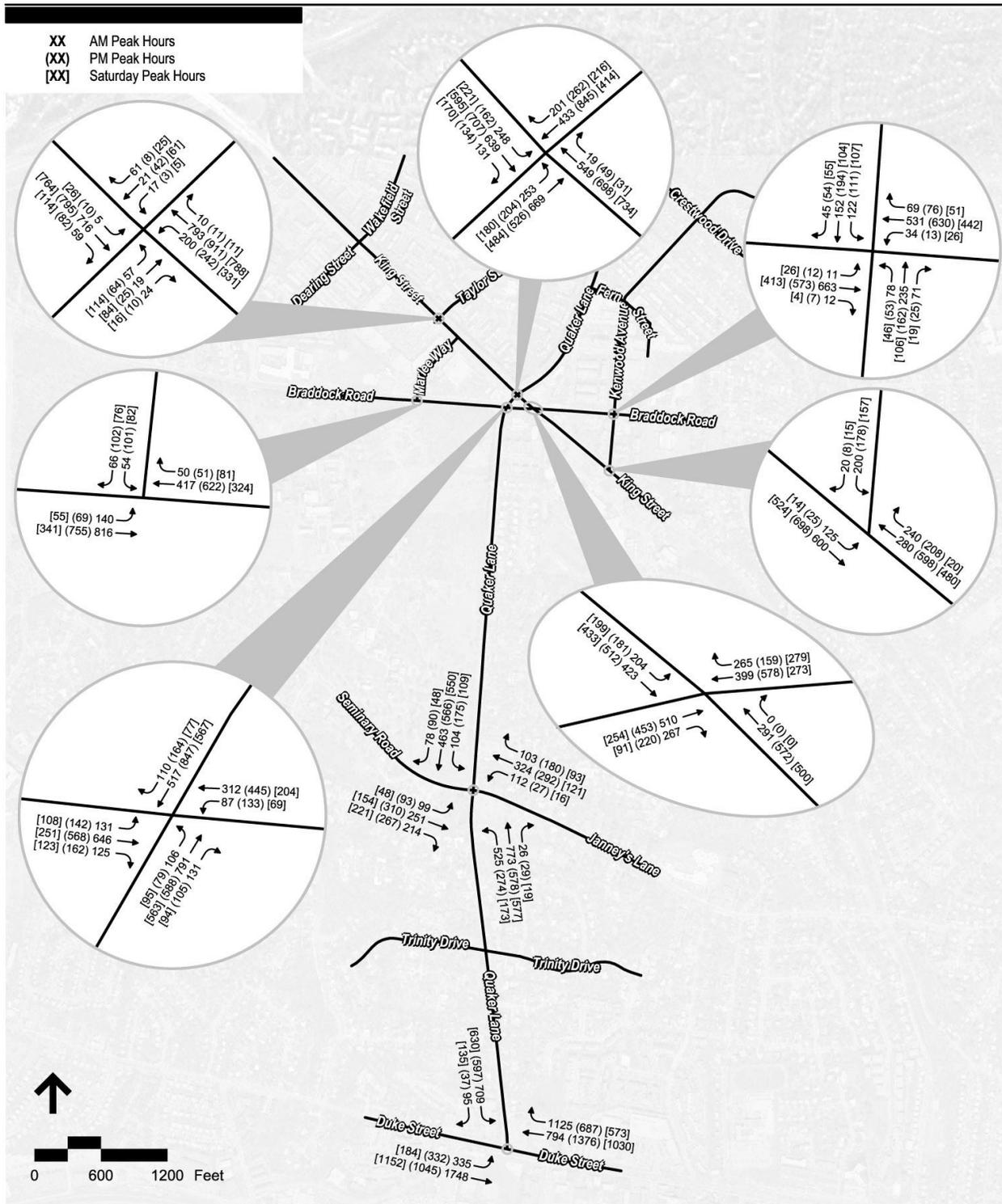


Figure 3: 2008 Peak Hour Volumes

### **3.3. Traffic Operations**

#### **Methodology**

The traffic analysis software program Synchro (Version 6, Build 614) was used to perform the traffic operational analysis of these signalized study intersections. Synchro network files were developed for this analysis and signal timing information was obtained from the City of Alexandria, which were incorporated into the Synchro datasets. The turning movement data and physical geometric configuration data provide the basis for evaluation of traffic operations at each intersection.

The evaluation criteria used to analyze area intersections and roadways in this traffic evaluation are based on the 2000 *Highway Capacity Manual* (HCM).<sup>1</sup> The HCM methodology results in various output parameters, referred to as Measures-of-Effectiveness (MOEs), including level-of-service. Level-of-service (LOS) is the term used to denote the different operating conditions that occur on a given roadway segment under various traffic volume loads. Level-of-service is a qualitative measure that considers a number of factors including roadway geometry, speed, travel delay and freedom to maneuver. Level-of-service provides an index to the operational qualities of a roadway segment or an intersection. Level-of-service designations range from A to F, with LOS A representing the best operating conditions and LOS F representing the worst operating conditions. For signalized intersections, the analysis considers the operation of all traffic entering the intersection and a LOS designation is provided for overall conditions at the intersection.

At both signalized and unsignalized intersections, two other MOEs are typically used to quantify traffic operations, in addition to LOS. These are volume-to-capacity ratio (V/C) and delay (expressed in seconds per vehicle). For example, an existing V/C ratio of 0.9 for an intersection indicates that the intersection is operating at 90 percent of its capacity. A delay of 15 seconds for a particular vehicular movement or approach indicates that vehicles on the movement or approach will experience an average additional travel time of 15 seconds. These additional MOEs (V/C and delay) have ranges of values for a given LOS letter designation. Comparison of intersection capacity results therefore requires that, in addition to the LOS, the other MOEs should also be considered.

---

<sup>1</sup> Transportation Research Board, *Highway Capacity Manual*, Washington, D.C., 2000

### **Capacity Analysis**

The study area intersections were analyzed for their operational performance using the HCM module within the Synchro software. **Table 1** presents the MOE results for each signalized intersection during the existing weekday morning, weekday evening, and Saturday peak hour conditions. **Table 2** provides left turn delay and queue data for failing intersection approaches.

The results in **Table 1** indicate that both the Braddock Road / Quaker Lane and King Street / Quaker Lane intersections currently operate at capacity (LOS E) during the weekday morning peak hour. The Braddock Road / Quaker Lane intersection is operating at capacity due to heavy northbound volume while King Street / Quaker Lane is operating at capacity due to heavy eastbound and southbound volumes. For the King Street / Taylor Street intersection, the service road was not included as part of the analysis.

Additionally, the results indicate that the King Street / Quaker Lane and King Street / Braddock Road intersections operate at or above capacity (LOS E or F) during the weekday evening and Saturday peak hour conditions, due to the heavy approach volumes. Specifically, the heavy eastbound and southbound volume at the King Street / Quaker Lane intersection and heavy westbound volume at the King Street / Braddock Road intersection most directly contribute to the capacity constraints at these intersections.

### **3.4. Vehicle Speed Data**

Spot speed data, provided by the City of Alexandria, were reviewed to determine the 85<sup>th</sup> percentile speed for the Quaker Lane corridor, identifying locations where high vehicular speeds are observed. The results of the speed data review are provided in **Table 3**.

Based on the stealth speed survey, it was found that the average speed along Quaker Lane northbound, between Duke Street and Seminary Road, was higher than the posted speed limit by 5 mph while Quaker Lane southbound, between King Street and Seminary Road, was higher by 18 mph. This finding suggests the need for measures aimed at reducing the incidence of speeding, including either stricter enforcement or potential traffic calming measures along Quaker Lane southbound.

Table 1: Existing Conditions Signalized Intersection MOEs (1)

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Taylor St (2)            | 0.49         | B   | 16.1            | 0.55         | B   | 17.0            | 0.72               | C   | 29.7            |
| Eastbound                        |              | B   | 14.1            |              | B   | 19.0            |                    | D   | 41.1            |
| Westbound                        |              | B   | 13.0            |              | B   | 12.5            |                    | B   | 12.9            |
| Northbound                       |              | D   | 41.3            |              | D   | 40.7            |                    | E   | 67.9            |
| Southbound                       |              | D   | 38.6            |              | D   | 38.0            |                    | D   | 35.9            |
| King St/Quaker Lane              | 0.88         | E   | 63.1            | 1            | F   | 173.2           | 0.8                | E   | 63.4            |
| Eastbound                        |              | F   | 98.2            |              | E   | 77.2            |                    | F   | 82.9            |
| Westbound                        |              | C   | 32.4            |              | E   | 64.9            |                    | E   | 57.9            |
| Northbound                       |              | B   | 12.0            |              | B   | 12.9            |                    | A   | 9.4             |
| Southbound                       |              | F   | 108.8           |              | F   | 439.0           |                    | F   | 96.0            |
| King St/Braddock Rd              | 0.57         | D   | 38.0            | 0.71         | F   | 81.9            | 0.51               | E   | 69.7            |
| Eastbound                        |              | B   | 14.8            |              | B   | 15.0            |                    | A   | 2.7             |
| Westbound                        |              | E   | 59.6            |              | E   | 64.1            |                    | E   | 58.6            |
| Southeastbound                   |              | C   | 26.7            |              | B   | 19.4            |                    | C   | 27.2            |
| northwestbound                   |              | E   | 74.9            |              | F   | 259.1           |                    | F   | 181.9           |
| King St/Kenwood Ave              | 0.51         | B   | 14.1            | 0.44         | B   | 13.8            | 0.34               | B   | 12.4            |
| Southbound                       |              | B   | 17.3            |              | B   | 17.3            |                    | B   | 16.6            |
| Southeastbound                   |              | B   | 15.4            |              | B   | 13.3            |                    | B   | 11.8            |
| northwestbound                   |              | B   | 11.0            |              | B   | 13.4            |                    | B   | 11.5            |
| Braddock Rd/Marlee Way           | 0.33         | A   | 5.2             | 0.37         | A   | 5.9             | 0.21               | A   | 6.3             |
| Eastbound                        |              | A   | 3.9             |              | A   | 4.0             |                    | A   | 3.1             |
| Westbound                        |              | A   | 3.2             |              | A   | 3.9             |                    | A   | 3.2             |
| Southbound                       |              | C   | 23.2            |              | C   | 20.3            |                    | C   | 22.0            |
| Braddock Rd/Quaker Ln            | 0.75         | E   | 58.6            | 0.77         | D   | 53.0            | 0.54               | D   | 42.0            |
| Eastbound                        |              | E   | 55.1            |              | E   | 57.3            |                    | D   | 49.3            |
| Westbound                        |              | B   | 19.7            |              | B   | 18.1            |                    | B   | 18.2            |
| Northbound                       |              | F   | 95.5            |              | E   | 60.4            |                    | E   | 59.2            |
| Southbound                       |              | C   | 28.2            |              | E   | 63.7            |                    | C   | 26.4            |
| Braddock Rd/Kenwood Ave          | 0.48         | B   | 10.2            | 0.44         | A   | 9.4             | 0.31               | A   | 9.1             |
| Eastbound                        |              | A   | 7.5             |              | A   | 6.8             |                    | A   | 4.9             |
| Westbound                        |              | A   | 7.4             |              | A   | 7.3             |                    | B   | 5.1             |
| Northbound                       |              | B   | 15.4            |              | B   | 14.1            |                    | B   | 17.8            |
| Southbound                       |              | B   | 15.0            |              | B   | 14.8            |                    | B   | 18.4            |
| Quaker Ln/Seminary Rd/Janneys Ln | 0.95         | D   | 45.4            | 0.8          | D   | 44.4            | 0.57               | C   | 23.9            |
| Eastbound                        |              | F   | 84.1            |              | F   | 99.3            |                    | C   | 30.1            |
| Westbound                        |              | D   | 37.0            |              | C   | 32.6            |                    | C   | 26.4            |
| Northbound                       |              | D   | 35.3            |              | C   | 22.0            |                    | B   | 19.3            |
| Southbound                       |              | D   | 39.0            |              | C   | 21.2            |                    | C   | 24.5            |
| Quaker Ln/Duke St                | 0.91         | C   | 24.3            | 1.09         | C   | 30.9            | 0.68               | B   | 18.2            |
| Eastbound                        |              | B   | 11.3            |              | D   | 39.1            |                    | A   | 8.1             |
| Westbound                        |              | C   | 24.0            |              | B   | 18.9            |                    | B   | 17.0            |
| Southbound                       |              | E   | 59.0            |              | D   | 52.2            |                    | D   | 38.2            |

Notes:

1. Results are from the HCM module in Synchro
2. Signalized intersection only, does not include service road.

Table 2: Existing Left Turn Delays and Queues

| Existing Conditions - Left Turn MOEs (Failing Approaches Only) |                  |          |                       |                 |     |                          |                       |                 |     |                          |                       |                 |     |                          |
|----------------------------------------------------------------|------------------|----------|-----------------------|-----------------|-----|--------------------------|-----------------------|-----------------|-----|--------------------------|-----------------------|-----------------|-----|--------------------------|
| Signalized Intersection Location                               | Failing Approach | Movement | AM Peak Hour          |                 |     |                          | PM Peak Hour          |                 |     |                          | Saturday Peak Hour    |                 |     |                          |
|                                                                |                  |          | V/C                   | Delay (sec/veh) | LOS | Queue (ft.) <sup>1</sup> | V/C                   | Delay (sec/veh) | LOS | Queue (ft.) <sup>1</sup> | V/C                   | Delay (sec/veh) | LOS | Queue (ft.) <sup>1</sup> |
| King St/Taylor St.                                             | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| King St/Quaker Lane                                            | Eastbound        | EBL      | 1.21                  | 199.3           | F   | 15                       | 0.79                  | 85.4            | F   | #311                     | 1.06                  | 149.0           | F   | #475                     |
|                                                                | Southbound       | SBT      | 1.05                  | 129.2           | F   | #413                     | 2.04                  | 550.1           | F   | #961                     | 1.00                  | 113.3           | F   | #388                     |
| King St/Braddock Rd                                            | Northwestbound   | NWT      | No Failing Approaches |                 |     |                          | 1.39                  | 259.1           | F   | #602                     | 1.20                  | 183.1           | F   | #504                     |
| King St/Kenwood Ave                                            | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Braddock Rd/Marlee Way                                         | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Braddock Rd/Quaker Ln                                          | Northbound       | NBL      | 0.51                  | 68.6            | E   | 190                      | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
|                                                                | Northbound       | NBT      | 1.04                  | 98.6            | F   | #750                     | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Braddock Rd/Kenwood Ave                                        | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Quaker Ln/Seminary Rd/Janneys Ln                               | Eastbound        | EBL      | 0.38                  | 29.1            | C   | 96                       | 0.35                  | 22.1            | C   | 88                       | No Failing Approaches |                 |     |                          |
|                                                                | Eastbound        | EBTR     | 1.04                  | 95.9            | F   | #610                     | 1.13                  | 114.4           | F   | #799                     | No Failing Approaches |                 |     |                          |
| Quaker Ln/Duke St                                              | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |

Notes:  
 1 - 95th percentile queue length  
 # - 95th percentile volume exceeds capacity, queue may be longer.

**Table 3: Stealth Speed Survey**

|              | Location                     | Date    | Posted Speed, mph | Total Vehicles | Minimum Speed, mph | Maximum Speed, mph | Average Speed, mph | 50th Percentile, mph | 85th Percentile, mph | Ten Mile Pace, mph |
|--------------|------------------------------|---------|-------------------|----------------|--------------------|--------------------|--------------------|----------------------|----------------------|--------------------|
| Quaker Ln NB | Btw Duke St and Seminary Rd  | 1/21/03 | 25                | 11926          | 11                 | 63                 | 28.36              | 30                   | 38                   | 29 to 38           |
| Quaker Ln SB | Btw King St and Seminary Rd  | 1/21/03 | 25                | 3606           | 11                 | 67                 | 37.52              | 38                   | 43                   | 33 to 42           |
| Quaker Ln    | Btw Fern St and Crestwood Dr | 2/14/02 | 35                | 6352           | 11                 | 47                 | 28.84              | 29                   | 34                   | 25 to 34           |
| Quaker Ln    | not specified                | 1/16/02 | 35                | 8374           | 11                 | 59                 | 33.85              | 34                   | 39                   | 30 to 39           |

- Ten Mile Pace: Ten Mile per Hour range of speeds containing the greatest number of observed speeds.
- 85<sup>th</sup> percentile: The speed at or below which 85 percent of the motorists drive on a given road unaffected by slower traffic or poor weather which is normally considered to be the highest safe speed for a roadway section.
- 50<sup>th</sup> percentile: The median speed of vehicles at the study location where half of the vehicles observed are going faster than the 50th percentile speed, and half are going slower.

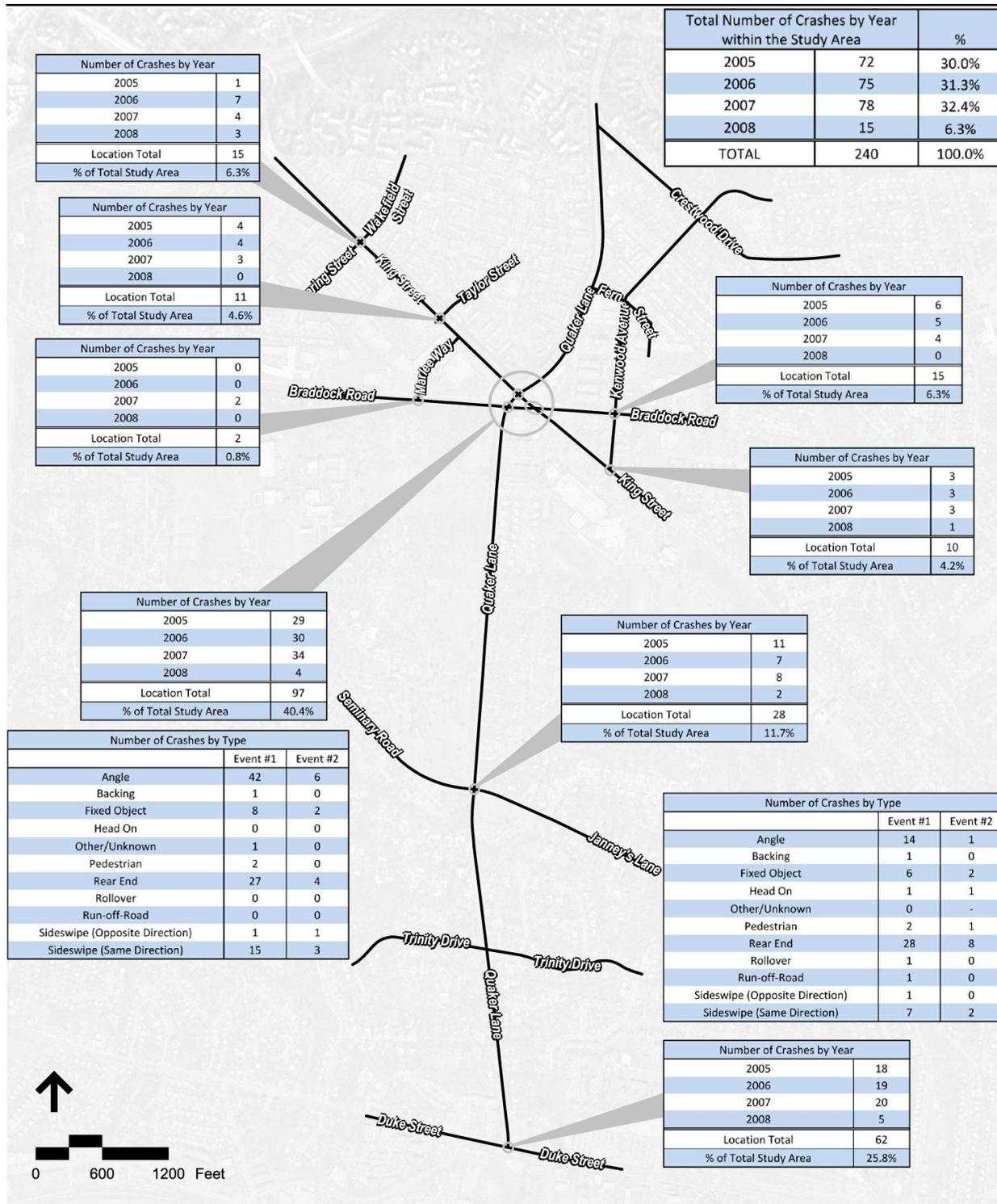
Ref: Ohio DOT

<http://www.dot.state.oh.us/dist1/planning/trafficstudies/speedzones.htm>

### 3.5. Crash Summary

To address any traffic safety issues within the study area, a review of vehicle crash data was conducted. Crash data for most recent three year period available, 2005 to 2007, and the first three months of data for 2008 conditions were provided by the City of Alexandria.

A summary of the overall crash data is presented in **Figure 4**. As shown in this figure, approximately 40% of the total crashes that occurred within the study area are concentrated at the three closely spaced intersections of King Street / Quaker Lane, King Street / Braddock Road, and Braddock Road / Quaker Lane. The high concentration of crashes at these closely spaced intersections indicates that improvements to reduce crash incidence and/or severity should be considered at this location.



Note: 2008 data represents January through March only

Figure 4: Overview of Crash Data 2005-2008

The crash data was analyzed in different categories to identify any possible trends in crash causality. The data was reduced to include severity of accident (property damage, personal injury, fatality), type of accident, time-of-day, and lighting and road conditions as summarized in **Table 4**. For this purpose, crash data was further broken down for each year and in order to compare full year's worth of data, 2008 crash data was excluded in this table. The intersections analyzed include the nine major signalized study intersections identified earlier, along with the intersection of King Street at N. Dearing Street / S. Wakefield Street.

As shown in **Table 4**, between January 2005 and December 2007, 225 total crashes occurred in the study area. These collisions resulted in 169 property damage only related crashes and 56 injury related crash occurrences, but no fatalities.

In terms of accident type, approximately 41 percent of the crashes during the analysis year were angle collisions which includes right angle, and left and right turn crashes, while 32 percent of the crashes were rear-end collisions. In addition, about 14 percent of the crashes were sideswipe collisions. Eight percent of the crashes involved a single vehicle running off the road and hitting a fixed object. It is interesting to note that the number and types of crashes occurring for each year are showing a consistent pattern. Thirty-seven (37) of the total 225 crashes involved two events within the crash (i.e. vehicle 1 sideswiped vehicle 2, then ran into the rear of vehicle 3).

The highest number of crashes occurred during AM and PM peak period conditions where approximately 34 percent of crashes occurred during the four and a half hour time frame which is typical weekday morning and evening peak commuter period. Also, a majority of the crashes occurred during daylight conditions. Almost a quarter of the crashes occurred at night, when the street is lighted. In addition, the prevalent driving conditions of the roadway surface during the crashes during the analysis period shows that approximately 79 percent of the crashes occurred while the pavement was dry. Wet, snowy, or icy pavement was reported for 21 percent of the crashes.

Table 4: Total Number of Crashes by Type

|                            | 2005      | 2006      | 2007      | Total      | Percent of Total |
|----------------------------|-----------|-----------|-----------|------------|------------------|
| <b>Accident Severity</b>   |           |           |           |            |                  |
| Fatal                      | 0         | 0         | 0         | 0          | 0%               |
| Injury Accidents           | 18        | 24        | 14        | 56         | 24.9%            |
| Property Damage Only       | 54        | 51        | 64        | 169        | 75.1%            |
| <b>TOTAL</b>               | <b>72</b> | <b>75</b> | <b>78</b> | <b>225</b> | <b>100%</b>      |
| <b>Accident Type</b>       |           |           |           |            |                  |
| Right Angle                | 11        | 13        | 10        | 34         | 15.1%            |
| Left Turn                  | 15        | 14        | 13        | 42         | 18.7%            |
| Right Turn                 | 6         | 6         | 4         | 16         | 7.1%             |
| Rear End                   | 22        | 25        | 25        | 72         | 32.0%            |
| Sideswipe                  | 9         | 11        | 11        | 31         | 13.8%            |
| Head On                    | 0         | 0         | 1         | 1          | 0.4%             |
| Fixed Object               | 5         | 3         | 7         | 15         | 6.7%             |
| Pedestrian                 | 1         | 2         | 2         | 5          | 2.2%             |
| Ran Off Road               | 0         | 0         | 2         | 2          | 0.9%             |
| Other                      | 3         | 1         | 3         | 7          | 3.1%             |
| <b>TOTAL</b>               | <b>72</b> | <b>75</b> | <b>78</b> | <b>225</b> | <b>100.0%</b>    |
| <b>Times</b>               |           |           |           |            |                  |
| 7:30 AM – 9:30 AM          | 9         | 10        | 15        | 34         | 15.1%            |
| 9:30 AM – 4:00 PM          | 30        | 33        | 33        | 96         | 42.7%            |
| 4:00 PM – 6:30 PM          | 16        | 13        | 14        | 43         | 19.1%            |
| 6:30 PM – 7:30 AM          | 17        | 19        | 16        | 52         | 23.1%            |
| <b>Lighting Conditions</b> |           |           |           |            |                  |
| Daytime                    | 53        | 53        | 59        | 165        | 73.3%            |
| Dusk                       | 1         | 5         | 1         | 7          | 3.1%             |
| Nighttime                  | 18        | 17        | 18        | 53         | 23.6%            |
| <b>Roadway Conditions</b>  |           |           |           |            |                  |
| Dry                        | 56        | 64        | 57        | 177        | 78.7%            |
| Icy                        | 1         | 0         | 3         | 4          | 1.8%             |
| Snow                       | 1         | 1         | 1         | 3          | 1.3%             |
| Wet                        | 14        | 10        | 17        | 41         | 18.2%            |
| <b>TOTAL</b>               | <b>72</b> | <b>75</b> | <b>78</b> | <b>225</b> | <b>100.0%</b>    |

### **3.6. Safety Review of King Street / Braddock Road/ Quaker Lane intersections**

A detailed safety review of the three intersections of King Street / Braddock Road/ Quaker Lane was completed. Items considered in this field review were focused on specific crash types and general pedestrian facilities. The following is a summary of findings from the crash data along with safety-related observations made at the King Street / Braddock Road/ Quaker Lane intersection area during the field the visit.

#### **King Street / Quaker Lane Intersection Crash Data and Field Observation Summary**

- Total number of crashes that occurred from 2005 to 2008 for a period of three years and three months was 44 crashes, which was the highest crash occurrence among the three intersections. Fifteen angle (34.1%), fifteen rear end (34.1%), and eight sideswipe (Same Direction) (18.2%) crashes accounted for 86.4% of the total crashes that occurred at this intersection.
- Out of 15 angle crashes, 10 crashes involved the northbound approach, of which 7 were directly due to red light traffic violation of the northbound through movement, which collided with the westbound through movement.
- Out of 15 rear end crashes, 10 crashes involved the eastbound approach, while 4 involved the southbound approach.
- Out of 8 sideswipe (Same Direction) crashes , 6 crashes involved the eastbound approach
- Five crashes (11.4%) were fixed object related crashes.

The crash data shows that about half of the angle crashes that have occurred are directly related to red light traffic violations for the northbound approach wanting to pass through this intersection at their phase within their cycle. Based on the field review, delay was also occurring at the upstream intersection of Braddock Road and Quaker Lane during the peak condition. A high number of red light violations, especially for the northbound approach, may be due to the lack of adequate separation between these two intersections, high volume of traffic and the resulting congestion.

#### **Braddock Road / Quaker Lane Intersection Crash Data and Field Observation Summary**

- Total number of crashes that occurred from 2005 to 2008 for period of three years and three months was 38 crashes, which was slightly lower than the crash occurrence at the intersection at King St and Quaker Lane. Seventeen angle (44.7%), eight rear end (21.1%), and seven sideswipe (same direction) (18.4%) crashes account for 84.2% of the total crashes at this intersection.

- Out of 17 angle crashes, 12 crashes involved the northbound approach, of which 8 were directly due to red light traffic violations for the northbound through movement, which collided with eastbound through movement.
- Out of 8 rear end crashes, 4 crashes involved the eastbound approach and 4 of involved the northbound approach.
- Out of 7 sideswipe (Same Direction) crashes, 5 crashes involved either the northbound or southbound approaches, while 2 crashes involved either the eastbound or westbound approaches.
- Three crashes (7.9%) were fixed object related crashes.

In addition, safety-related observations made at the Braddock Road/ Quaker Lane intersection area during the field visit are summarized as follows.

- Utility pole placed in the sidewalk on the southwest quadrant along the south side of the Braddock Road and the attached power company box to this pole is obstructing pedestrian mobility. In addition, the pedestrian crossing sign is attached too high to this utility pole for the Braddock Road eastbound approaching vehicles to recognize it.
- There is a possibility that the drivers along Braddock Road eastbound at Quaker Lane would confuse the signal heads placed at King Street due to the close proximity of the two intersections along Braddock Road.
- There are frequent occurrences where pedestrians are crossing the roadway at locations where crosswalks are undesignated in order to get to their destination via the shortest path and avoid crossing multiple crosswalks.
- The western-most pedestrian ramp on the south side of the Braddock Road eastbound approach, leading to the channelizing island, is obstructed from sight due to the brick wall and utility pole.
- Due to the horizontal alignment along Quaker Lane and the overgrown trees placed on the right side of the roadway, it is difficult to detect in advance the signal heads for the northbound approach along Quaker Lane.
- Plastic poles with reflector tapes attached are placed at the median islands to warn drivers about the median islands and to advise drivers to keep to right of the roadway. However, along the west leg of the intersection, the pole is missing.
- Pedestrian crossing sign is blocked for the northbound approach along Quaker Lane due to overgrown trees.

- Braddock Road eastbound approach at the intersection with Quaker Lane does not exactly align with the downstream receiving lanes at the intersection with King Street. There exists an offset where the driver has to make a slight right turn maneuver in order to properly travel along the receiving lanes.

### **King Street / Braddock Road Intersection Crash Data and Field Observation Summary**

- Total number of crashes that occurred from 2005 to 2008 for period of three years and three months was 15 crashes, where ten angle (66.7%) and four rear end (26.7%) crashes accounted for 93.3% of the total crashes at this intersection.
- Out of 10 angle crashes, 8 crashes involved the northbound approach where 4 were directly due to red light traffic violations of the northbound through movement, which collided with westbound through movement. Three crashes were due to a northbound left turn violation, where the left turn is a prohibited movement.
- Four rear end crashes were involving either the westbound or eastbound approaches.

In addition, safety-related observations during the field visit made at the intersection of King Street and Braddock Road are summarized as follows.

- No crosswalks are provided along any of the legs at this intersection, although there are frequent pedestrian activities and jaywalking occurring in the vicinity of this intersection.
- Since signal heads for both the northbound and westbound approaches are placed along the same wire in close proximity, louvers are placed at the signal heads for the westbound approach to prevent the drivers of the northbound approach from mistaking the westbound signal head as the signal head for northbound. Placement of these louvers for the westbound phase, especially during the red phase, is not clearly visible for the westbound approach until they approach close to the intersection.

Additional safety-related observations made at the vicinity of the King Street / Braddock Road/ Quaker Lane intersection area include:

- Heavy school bus traffic stopping at bus stops resulted in through traffic queue spillback into adjacent intersections, especially along Braddock Road near the intersection with Radford Street and Kenwood Avenue where only one through lane is provided for the eastbound approach.

- During the PM period when school classes end, all of the school buses exiting from TC Williams High School are routed to travel along King Street eastbound to make a left turn onto Kenwood Avenue. However, there is no protected left turn from King Street to Kenwood Avenue.
- At the intersection of Braddock Street / Kenwood Avenue, no lane markings are provided along the westbound and northbound approaches. This results in queuing along the Kenwood Avenue northbound approach and the King Street eastbound approach since signals at the Braddock Road / Kenwood Avenue intersection and King Street / Kenwood Avenue serve as constraints for these particular movements.
- The parking lot provided for the small shopping building in the northeast quadrant of the King Street / Quaker Lane intersection is situated directly along the travel lanes of Quaker Lane, with no buffer from the roadway. Observations revealed that vehicles reversing out of parking stalls often back up into the travel lanes.

### **3.7. Safety Review of King Street / Dearing Street / Wakefield Street Intersection**

At the request of the City of Alexandria, a safety review of the intersection of King Street at Dearing / Wakefield Streets was completed. During the period from January 2005 to March 2008, 15 crashes were reported at this location.

A review of this intersection's crash history resulted in no clear trend or identification of one overwhelming specific type of collision. However, a field visit of the intersection was conducted to examine safety considerations. The following is a summary of important observations from the field visit:

1. The location of the westbound stop sign is past the stop bar, by the far side line of the pedestrian walk way. Therefore:
  - Vehicles behave as if the far line is a stop bar, which blocks the crosswalk to pedestrians.
  - The position of vehicles is off the in-pavement signal loop detector, so a single vehicle may not trigger a call to activate the signal phase.
2. The centerline of the service road along either side of Dearing Street does not align. Therefore:
  - The offset travel way may contribute to driver confusion and potential vehicle conflicts, as there are no pavement markings in the intersection to guide vehicles.
  - The wide travel lane approach (eastbound) to the intersection can result in high approach speeds.

- As buses enter the service road from King Street, they overhang into the opposing direction travel lane. The tight curb radii and relatively narrow lane widths contribute to this undesirable circumstance.

### **3.8. Pedestrian Facilities**

A detailed description of pedestrian facilities at the study intersections is presented below that includes information regarding crosswalks, sidewalks, ADA ramps, pedestrian signals, pushbuttons and pedestrian crossing intervals.

#### **1. Quaker Lane / Duke Street**

- Crosswalks are marked along the west and north legs of the intersection, which are all signalized and have push buttons with ADA ramps.
- Pole for luminaire is placed in the middle of the sidewalk at the northeast quadrant of the intersection; not enough space for a wheelchair to maneuver around the pole without going onto the grass. A possible remedy measure would be to push the retaining wall back, in order to increase effective sidewalk width.
- Push button placed at northside of the west leg crosswalk is too low.
- Sidewalks are provided along all legs of the intersection.

#### **2. Quaker Lane / Trinity Drive**

- There are no marked crosswalks at this intersection and for pedestrian crossing. The nearest marked crosswalks are the signalized crossings at either Duke or at Seminary / Janneys Lane, where the intersections are spaced approximately 3,300 feet apart.
- Sidewalks are provided at all legs of the intersection except along the north side of the west leg.
- ADA ramps are provided for crossing Trinity Drive.

#### **3. Quaker Lane / Seminary Road / Janneys Lane**

- All legs of the intersection have marked crosswalks with ADA ramps and pedestrian signal heads, but only one push button is placed for each corner. Pedestrian exclusive phase is provided simultaneously at all of the four crosswalks when the push button is activated.
- Sidewalks are provided along all legs of the intersection.

#### **4. Quaker Lane / Key Drive**

- There are no marked crosswalks at this intersection.
- Sidewalks are provided along Quaker Lane with ADA ramps for crossing Key Drive.
- No sidewalks are provided for the side street.

#### **5. Quaker Lane / Bishop Lane**

- Sidewalks are provided along Quaker Lane with ADA ramps for crossing Bishop Lane.
- No sidewalks are provided for the side street.
- No marked crosswalks are provided and the nearest marked crosswalk is either Braddock or Seminary / Janneys.

6. Quaker Lane / Woods Avenue
  - Sidewalks are provided along all legs of the intersection with ADA ramps for crossing Woods Avenue.
  - No marked crosswalks are provided for pedestrians crossing North Quaker Lane. The nearest marked crosswalk is at Braddock and a marked crosswalk is provided along Woods Avenue.
  
7. Intersection of King Street, Braddock Road and Quaker Lane
  - Due to the complexity of the intersection, not every leg has a crosswalk.
  - Braddock / North Quaker Lane - Crosswalks with ADA ramps are placed along the west and south legs of the intersection, and pedestrian signals and pedestrian buttons are provided at these crosswalks. Sidewalks are provided along south and west legs of the intersection while along east leg, sidewalks are only provided along the south side.
  - North Quaker Lane / King Street - Crosswalks with ADA ramps are placed along the west leg and north leg of the intersection, and pedestrian signals and pedestrian buttons are installed at these crosswalks. However, pedestrian button located at east side of the north leg is not easily accessible from wheelchairs. Sidewalks are provided on the west side of the north leg and south side of the west leg of service road. Only crosswalk markings without pedestrian signals or pedestrian buttons are provided at the crossing of the service road.
  - Braddock Road / King Street – no crosswalks are marked. Sidewalks are provided along the south leg and the east leg of the intersection. Along the west leg, sidewalks are provided only on the north side. ADA ramp is only placed on the eastside of the south leg.
  
8. Braddock Road / Radford Street
  - Crosswalks with ADA ramps are placed for all four legs of this unsignalized intersection.
  - Sidewalks are provided at all legs of the intersection.
  
9. Braddock Road / Kenwood Avenue
  - Crosswalks with ADA ramps are marked for all four legs with pedestrian signals for all approaches. Two separate pedestrian buttons are provided for each of the southwest and southeast corners, but only one pedestrian button is provided for the northeast and northwest corners. The crosswalks at the north and the south leg are placed on pedestrian recall.
  - Sidewalks are provided at all legs of the intersection.
  
10. King Street / Kenwood Avenue
  - Crosswalks with ADA ramps are placed along all four legs with pedestrian signals and pedestrian buttons provided at these crosswalks.
  - Pedestrian push buttons located at northeast corner are too high for wheel chair access.
  - Sidewalks provided at all legs of the intersection.
  
11. King Street / Taylor Street
  - Crosswalks with ADA ramps are placed along all four legs including the service road. Pedestrian signals and buttons are only provided for the west and east legs along King Street (used for crossing King Street) and not the service road. Flashing red lights are provided along the service road. Only pedestrian signals are only provided for the north leg.
  - Poles are in the crosswalk at King Street/ Taylor Street.
  - King Street, west of the intersection with Braddock Road and Quaker Lane, has no sidewalk along the north side. Sidewalk exists along the south side service road.

12. Braddock Road / Marlee Way

- This intersection does not have countdown pedestrian heads. Instead, “Don’t Walk/Walk” signals are provided.
- Crosswalks are marked along the east and north legs of the intersection.
- Marlee Way has narrow sidewalks and includes ADA ramps.

Initial comments concerning pedestrian flows from the citizens who attended the first Public Information Meeting indicate that pedestrian walk times appear to be too short at the following intersections:

- King Street at Dearing Street / Wakefield Street
- King Street at Taylor Street
- Quaker Lane at King Street and Braddock Road

It should be noted that the City of Alexandria recently modified the pedestrian walk times, in the Spring of 2008. The comments from citizens regarding this issue were received prior to the implementation of these new pedestrian walk times. However, based on the recent field survey performed during May of 2009, it was observed that the pedestrian walk times still appear to be too short at the crosswalks of the following study intersections:

- King Street at Dearing Street / Wakefield Street
  - Crosswalk placed at east leg (King Street) with pedestrian walk time at 20 seconds while recommended time is approximately 25 seconds when assuming 7 seconds of walk time and 3.5 ft/sec of walking speed.
  - Also, pedestrian signal placed at north leg (Wakefield Street) is not operating.
- Quaker Lane at King Street
  - Crosswalk placed at north leg (Quaker Lane) with pedestrian walk time at 25 seconds while recommended time is approximately 30 seconds when assuming 7 seconds of walk time and 3.5 ft/sec of walking speed.
  - Also, pedestrian button placed at west leg (King Street) needs to be rechecked since it seems to be out of order.

Any future roadway improvements should strive in their design to improve pedestrian flows and safety in the study area. Construction of a pedestrian bridge or tunnel is not under consideration at this time due to the potential high cost, design constraints, and safety concerns associated with these options.

### 3.9. Transit Service

The results of an assessment of transit services in the study area, including an analysis of ridership and bus stops, is presented in this section. Metrobus and DASH routes serve the study area with stop locations located along the main roadways as illustrated in **Figure 5**. As previously discussed, the majority of the bus stops do not provide a bus pullout bay, which contributes to congestion and driver frustration at numerous locations within the study area. **Table 5** describes the bus routes that operate within the study area, roadways served by these bus routes and the number of bus stops for these bus routes within the study area.

**Table 5: Bus Routes within Study Area**

| Bus Routes        | Roadways served                                        | Number of Stops* |
|-------------------|--------------------------------------------------------|------------------|
| Metrobus 28A      | King Street, including the service road                | 7                |
| Metrobus 28B      | Seminary Road and Janneys Lane                         | 4                |
| Metrobus 28K, 28N | Duke Street                                            | 2                |
| Metrobus 8X       | Seminary Road and Quaker Lane (north of Seminary Road) | 8                |
| Metrobus 8Z       | Quaker Lane                                            | 10               |
| DASH AT2          | Seminary Road and Janneys Lane                         | 4                |
| DASH AT5, AT6     | King Street, including the service road                | 7                |
| DASH AT8          | Duke Street                                            | 2                |

\* Stops located within Study Area, additional stops exist outside the Study Area

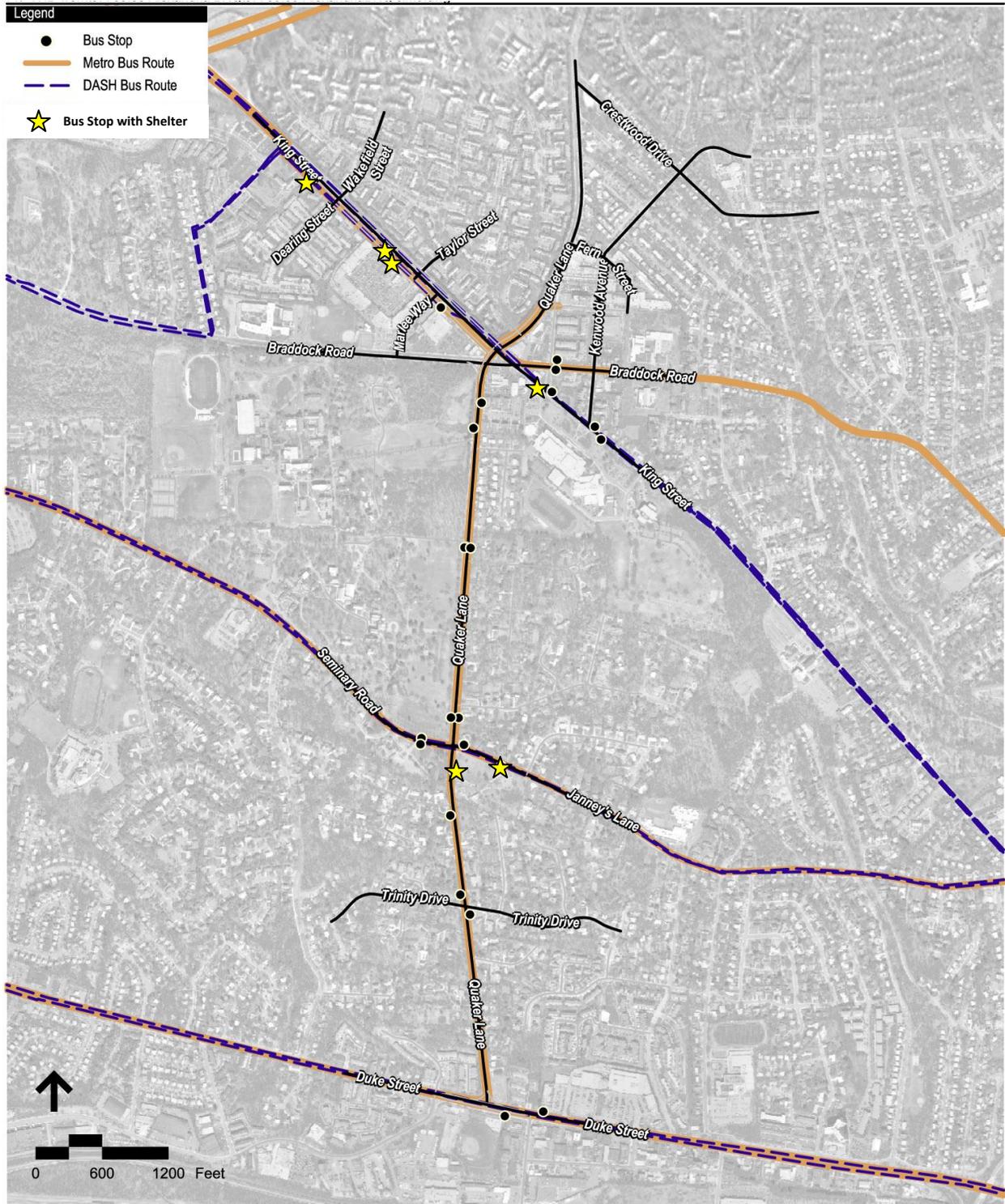


Figure 5: Metrobus and DASH Bus Routes

Existing and future ridership levels at each stop location within or adjacent to the study area are summarized in **Table 6** for Metrobus and **Table 7** for DASH. As shown in these tables, routes operating along King Street, particularly those serving the Bradlee Shopping Center, experience high numbers of boarding and alighting passengers.

Table 6: WMATA Metrobus Daily Ridership at Select Bus Stops

| WMATA                           |                 |            |           |                 |            |           |           |           |           |                 |           |                 |           |
|---------------------------------|-----------------|------------|-----------|-----------------|------------|-----------|-----------|-----------|-----------|-----------------|-----------|-----------------|-----------|
|                                 |                 | Weekday    |           |                 |            | Saturday  |           | Sunday    |           | Saturday        |           | Sunday          |           |
|                                 |                 | 2009       |           | 2020 Projection |            | 2009      |           | 2009      |           | 2020 Projection |           | 2020 Projection |           |
| Location                        | Route Direction | Boarding   | Alighting | Boarding        | Alighting  | Boarding  | Alighting | Boarding  | Alighting | Boarding        | Alighting | Boarding        | Alighting |
| Bradlee Shopping Center         | Westbound       | 31         | 17        | 57              | 31         | 16        | 28        | 12        | 19        | 21              | 31        | 19              | 27        |
| King Street & Dearing           | Eastbound       | 21         | 10        | 32              | 15         | 19        | 13        | 9         | 5         | 23              | 18        | 14              | 9         |
| Bradlee Shopping Center         | Eastbound       | 16         | 14        | 29              | 31         | 12        | 10        | 8         | 5         | 28              | 19        | 14              | 8         |
| King Street & Dearing           | Westbound       | 7          | 26        | 16              | 30         | 5         | 20        | 2         | 11        | 15              | 31        | 6               | 15        |
| King Street & Marlee Way        | Eastbound       | 6          | 2         | 18              | 11         | 4         | 1         | 0         | 0         | 11              | 8         | 2               | 3         |
| Radford Street & N. Quaker Lane | Northbound      | 4          | 5         | 9               | 12         | 3         | 2         | 1         | 1         | 7               | 3         | 4               | 5         |
| W. Braddock & Marlee Way        | Westbound       | 2          | 0         | 12              | 7          | 1         | 0         | 0         | 0         | 9               | 3         | 3               | 6         |
| N. Quaker Lane & Woods Ave      | Northbound      | 2          | 1         | 8               | 4          | 0         | 0         | 0         | 0         | 2               | 2         | 1               | 1         |
| N. Quaker Lane & Woods Ave      | Southbound      | 1          | 6         | 6               | 10         | 0         | 0         | 0         | 0         | 1               | 2         | 1               | 1         |
| N. Quaker Lane & Osage Street   | Northbound      | 1          | 5         | 5               | 9          | 0         | 0         | 0         | 0         | 3               | 7         | 2               | 5         |
| W. Braddock & Marlee Way        | Eastbound       | 0          | 0         | 14              | 6          | 5         | 0         | 2         | 1         | 10              | 6         | 6               | 2         |
| King Street & Menokin Drive     | Eastbound       | 12         | 2         | 23              | 8          | 11        | 5         | 8         | 3         | 18              | 13        | 14              | 8         |
| King Street & Menokin Drive     | Westbound       | 3          | 7         | 9               | 14         | 2         | 9         | 1         | 5         | 9               | 18        | 4               | 7         |
| <b>Totals</b>                   |                 | <b>106</b> | <b>95</b> | <b>238</b>      | <b>188</b> | <b>78</b> | <b>88</b> | <b>43</b> | <b>50</b> | 157             | 161       | 90              | 97        |

Table 7: DASH Daily Ridership at Select Bus Stops

| DASH                         |                 |            |            |                 |            |            |            |            |            |                 |            |                 |            |
|------------------------------|-----------------|------------|------------|-----------------|------------|------------|------------|------------|------------|-----------------|------------|-----------------|------------|
| Location                     |                 | Weekday    |            |                 |            | Saturday   |            | Sunday     |            | Saturday        |            | Sunday          |            |
|                              |                 | 2009       |            | 2020 Projection |            | 2009       |            | 2009       |            | 2020 Projection |            | 2020 Projection |            |
|                              |                 | Boarding   | Alighting  | Boarding        | Alighting  | Boarding   | Alighting  | Boarding   | Alighting  | Boarding        | Alighting  | Boarding        | Alighting  |
|                              | Route Direction |            |            |                 |            |            |            |            |            |                 |            |                 |            |
| Bradlee Shopping Center      | Westbound       | 116        | 118        | 132             | 146        | 45         | 71         | 28         | 47         | 52              | 83         | 35              | 61         |
| Bradlee Shopping Center      | Eastbound       | 80         | 60         | 93              | 73         | 76         | 41         | 37         | 26         | 81              | 54         | 51              | 35         |
| King Street & Kenwood        | Eastbound       | 80         | 30         | 99              | 42         | 25         | 27         | 14         | 13         | 33              | 38         | 19              | 15         |
| King Street & W. Braddock    | Eastbound       | 59         | 17         | 74              | 29         | 23         | 7          | 21         | 3          | 31              | 12         | 29              | 10         |
| King Street & Marlee Way     | Eastbound       | 26         | 16         | 41              | 23         | 12         | 6          | 6          | 0          | 18              | 11         | 9               | 2          |
| King Street & Dearing Street | Eastbound       | 26         | 16         | 36              | 25         | 14         | 6          | 4          | 0          | 21              | 9          | 7               | 1          |
| King Street & Radford Street | Westbound       | 19         | 47         | 24              | 61         | 21         | 38         | 4          | 12         | 30              | 47         | 8               | 18         |
| King Street & Quaker Lane    | Eastbound       | 19         | 0          | 27              | 8          | 2          | 7          | 1          | 0          | 8               | 15         | 3               | 1          |
| King Street & Dearing Street | Westbound       | 17         | 13         | 23              | 18         | 11         | 5          | 5          | 2          | 22              | 12         | 9               | 3          |
| King Street & Quincy Street  | Eastbound       | 14         | 4          | 19              | 7          | 6          | 1          | 0          | 4          | 10              | 4          | 4               | 8          |
| King Street & Quincy Street  | Westbound       | 1          | 1          | 5               | 2          | 0          | 4          | 0          | 2          | 2               | 8          | 1               | 5          |
| King Street & Menokin Drive  | Eastbound       | 25         | 10         | 32              | 16         | 19         | 1          | 8          | 5          | 29              | 7          | 15              | 8          |
| King Street & Menokin Drive  | Westbound       | 4          | 13         | 8               | 19         | 5          | 16         | 0          | 0          | 13              | 23         | 1               | 1          |
| <b>Totals</b>                |                 | <b>486</b> | <b>345</b> | <b>613</b>      | <b>469</b> | <b>259</b> | <b>230</b> | <b>128</b> | <b>114</b> | <b>350</b>      | <b>323</b> | <b>191</b>      | <b>168</b> |

### 3.10. Concerns of the Public

A summary of written community concerns and suggested solutions to problems in the study area, which were submitted by citizens during the first Public Information Meeting held at Minnie Howard Middle School on June 2, 2008, are summarized in **Table 8**. Full descriptions of the concerns and suggestions can be found in the Appendix.

**Table 8: Public Comments**

| Areas for Improvement              | Detailed Improvement Measures                                                                   | Problems and Issues                                                                                                                                                                                                                                                  |
|------------------------------------|-------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|
| Traffic enforcement and safety     | Improve Traffic enforcement (police presence)                                                   | King St red light violation at Taylor St and Wakefield St                                                                                                                                                                                                            |
|                                    | Lowering speed limit                                                                            | High speed along King St                                                                                                                                                                                                                                             |
| Improve geometric configurations   | Adjustment                                                                                      | Roadway height of side streets Taylor Street and Wakefield Street                                                                                                                                                                                                    |
|                                    | Do not raise/lower road way or crosswalks                                                       |                                                                                                                                                                                                                                                                      |
|                                    | Roundabout consideration                                                                        | Congestion at King Street/Braddock Road/Quaker Lane intersection                                                                                                                                                                                                     |
| Improve Way finding                | Better signage for side street traffic accessing King Street                                    |                                                                                                                                                                                                                                                                      |
|                                    | Lane painted or signage at Quaker Lane and Braddock Road                                        |                                                                                                                                                                                                                                                                      |
|                                    | Better pavement markings                                                                        |                                                                                                                                                                                                                                                                      |
|                                    | Bigger green guide signage                                                                      |                                                                                                                                                                                                                                                                      |
|                                    | Need better signage to indicate that the first turn bay is for Braddock only                    | NB Quaker backs up due to the left turns to both Braddock and King Street                                                                                                                                                                                            |
|                                    | Consider restriping the turn bay for Braddock to better indicate that this is for Braddock only |                                                                                                                                                                                                                                                                      |
| Improvement of Pedestrian access   | Trim on regular basis                                                                           | Vegetation overgrowth blocking line of sight and guide signs                                                                                                                                                                                                         |
|                                    | increase crosswalk time                                                                         | insufficient ped time crossing King Street from Taylor Street to Bradlee Shopping Center                                                                                                                                                                             |
|                                    | increase crosswalk time                                                                         | King Street / Wakefield Street pedestrian crossing time is too short to cross                                                                                                                                                                                        |
| Improve Service Road Operations    | Add pedestrian walkway                                                                          | absence of pedestrian walkway                                                                                                                                                                                                                                        |
|                                    | Reconfiguration and closure of the service road                                                 | Traffic from Taylor Street turning left onto service road has difficulty with traffic coming out of Bradlee Shopping Center                                                                                                                                          |
|                                    | Eliminate the brick pillar at Bradlee Shopping Center for better visual at entrance             | No left turns allowed from service road onto King Street at Bradlee main entrance                                                                                                                                                                                    |
|                                    | Recommend control by traffic signals, not flashing lights                                       | Sight distance issues at Bradlee Shopping Center                                                                                                                                                                                                                     |
|                                    | Simplify the traffic patterns in and out of Bradlee Shopping Center                             | Stop signs are not obeyed                                                                                                                                                                                                                                            |
| Minor Transit improvements         | More direct ins & outs to improve circulation                                                   |                                                                                                                                                                                                                                                                      |
|                                    |                                                                                                 | Transit on service road adds to congestion                                                                                                                                                                                                                           |
| Improve Overall Operational Issues | Synchronize traffic signals                                                                     | Braddock Road eastbound traffic from Bradlee Shopping Center to Old Town has significant delay during the evening rush hour                                                                                                                                          |
|                                    | Shorten westbound King Street green time at King Street and Wakefield Street intersection       |                                                                                                                                                                                                                                                                      |
|                                    | Recommended more signage to discourage traffic from using the KDW intersection                  | The King Street eastbound traffic bound for Bradlee Shopping Center makes a right turn at the King Street/Dearing Street/Wakefield Street (KDW) intersection instead of the slip ramp to the Service Road or the Taylor Street/King Street/Service Road intersection |

## **4. Future Conditions – Baseline Conditions**

The future Baseline Conditions (or No-Build Conditions) assumed 2020 as the target year for the traffic analysis. Future baseline volumes at the signalized intersections within the study area were developed using the Metropolitan Washington Council of Governments' (MWCOG) Travel Demand Model Version 2.1, Release D, Edition 50 and the Round 7 Cooperative Land Use Forecast. These regional land use forecasts included assumptions related to the BRAC realignment, including Mark Center. The forecast model network was reviewed and revisions were made as needed to ensure that the roadway network in the study was coded correctly. The existing year of the model network was assumed to be 2005, as the model is only provided in 5-year increments. The forecast model was then run for the 2020 future target year to determine the anticipated order of magnitude growth. The MWCOG model includes appropriate future roadway improvements per the region's constrained long range plan. At the time that this analysis was undertaken, there was no information available on any impacts the proposed I-395 HOT lanes may have on the study intersections.

These models are based on what is known as the four-step process involving Trip Generation, Trip Distribution, Mode Share, and Assignment. These four steps are described further below.

- **Trip Generation.** Trip generation accounts for movements between origins and destinations. The MWCOG model has over 2,100 traffic analysis zones (TAZ) and includes the major roadway network in the region. Each TAZ is assigned population and employment in several categories. Population is described in terms of households (single family, multi-family, etc.). Employment is described by employment type (office, retail, industrial, etc.). Within each zone, productions and attractions are generated based on typical behavior; population creates productions and employment creates attractions. Each trip requires a production and an attraction.
- **Trip Distribution.** Productions and attractions are balanced (matched) based on distribution patterns that have been observed in the region (zip code surveys and other travel data) and other factors such as travel times, average trip length, income, etc. This information is based on periodic surveys conducted by MWCOG and 2000 census data from the Census Transportation Planning Package, and the data is uploaded into the model and maintained by MWCOG. For large developments, focused surveys such as the zip code information provided to the Study Team are used to adjust the distribution.

The model has a “control total” for population and employment for each year modeled (normally five year increments) because the total population and employment for the region is much more predictable than individual TAZs. Control totals are also established for each jurisdiction. These control totals must be maintained; otherwise, results for projects throughout the region would not be consistent and would overestimate or underestimate impacts.

- **Mode Share.** Mode share, also referred to as mode split, is a person’s choice of mode of travel. A person can travel by automobile or by transit, or he can walk or bike. The automobile trip is carried out in one of two ways: either as a single occupancy vehicle (SOV) or high occupancy vehicle (HOV). In the Metropolitan Washington area, the type of HOV trip depends on the corridor as the I-95/I-395 facility requires a minimum of three persons per vehicle, while most facilities only require at least two people. Transit trips are made by bus or by train. The latter includes commuter trains or the Metrorail train. The MWCOC model calculates mode share for each TAZ based on demand, availability of service, and travel time.
- **Assignment.** After the trip generation, distribution, and mode share steps are completed, vehicle trips are assigned onto the roadway network by the model. The trips are assigned on the minimum path with capacity constraints, i.e., the trips are distributed on the links based on their origins or destinations until each link reaches capacity. Vehicle trips are loaded in an iterative manner to allow travel times to be recalculated to reflect congestion. As the most direct route becomes congested, vehicles are redirected to longer routes and the demand is balanced across the alternate routes available. This process plays a critical role in the way traffic changes created by the Proposed Action are analyzed. As traffic increases because of the new employment, people who used those routes to make their trip may divert to other routes to avoid congestion.

The model outputs for existing and future years were then used to develop turning movement volumes for the target year based on the existing turning movement counts, following the procedures prescribed in the National Cooperative Highway Research Program (NCHRP) Report 255. During this process, a minimum growth rate of one percent was assumed for any roadway links projected to experience less than one percent per year growth. Traffic volume projections at each intersection for future year baseline conditions are summarized in **Figure 6**.

Using the turning movement volumes for the future baseline condition, a traffic operational analysis for the signalized study intersections was performed using Synchro analysis software following a similar

approach as that of analyzing the existing conditions. Error! Reference source not found. and **Table 10** presents the Measures of Effectiveness (MOEs) for the signalized intersections under the 2020 baseline weekday morning, weekday evening, and Saturday peak hour conditions within the study area.

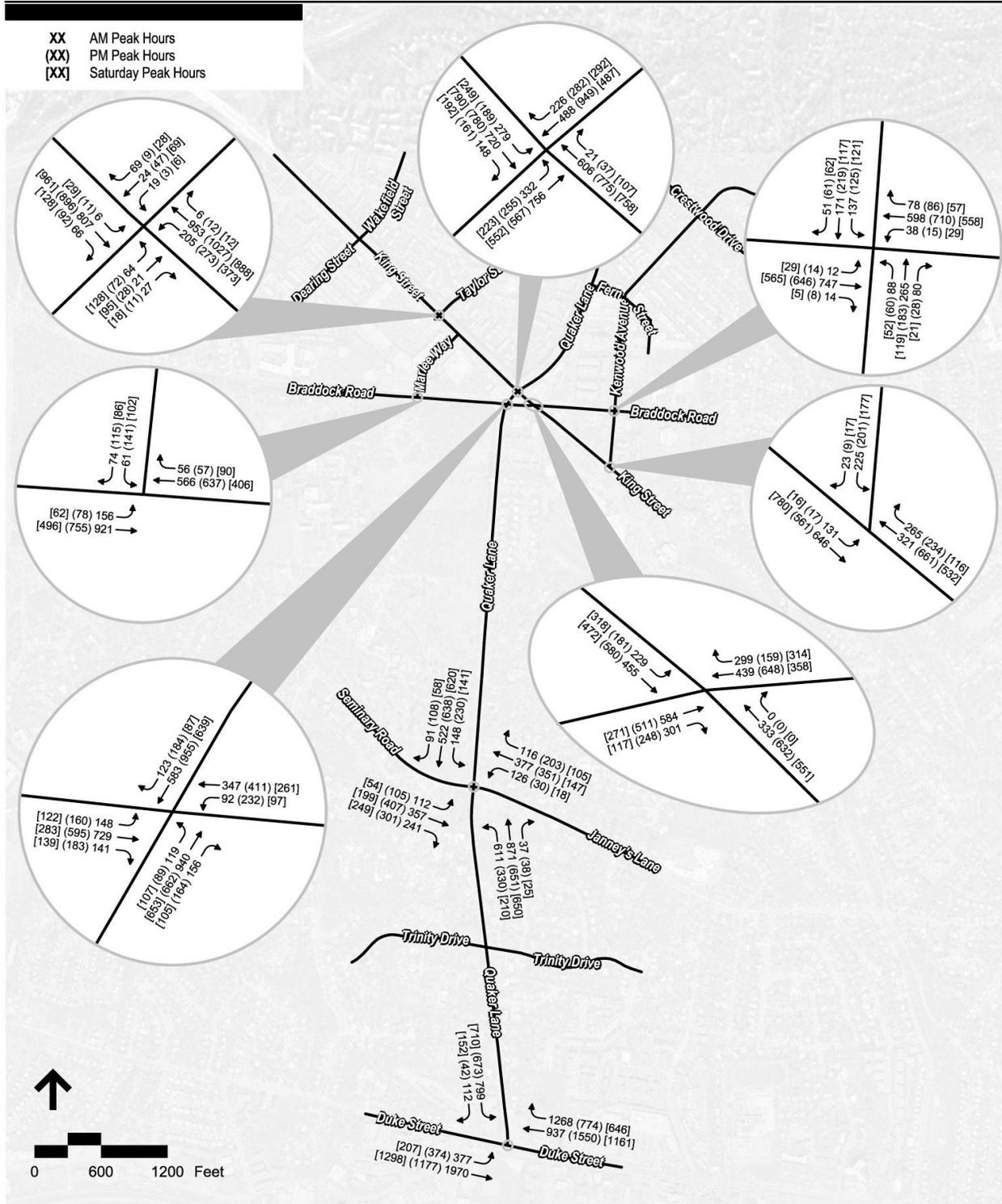


Figure 6: 2020 Peak Hour Volumes

Table 9: 2020 Baseline Signalized Intersection MOEs (1)

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Taylor St (2)            | 0.55         | B   | 18.2            | 0.63         | B   | 18.4            | 0.85               | F   | 85.7            |
| Eastbound                        |              | B   | 11.3            |              | C   | 23.5            |                    | F   | 171.6           |
| Westbound                        |              | B   | 10.7            |              | B   | 11.4            |                    | B   | 12.6            |
| Northbound                       |              | F   | 124.5           |              | D   | 45.2            |                    | F   | 95.0            |
| Southbound                       |              | D   | 43.3            |              | D   | 39.3            |                    | D   | 35.8            |
| King St/Quaker Lane              | 1.03         | E   | 78.9            | 1.14         | F   | 212.2           | 0.96               | F   | 92.2            |
| Eastbound                        |              | F   | 125.4           |              | F   | 106.9           |                    | F   | 138.3           |
| Westbound                        |              | C   | 35.0            |              | E   | 66.9            |                    | E   | 63.2            |
| Northbound                       |              | B   | 14.6            |              | B   | 14.1            |                    | B   | 10.4            |
| Southbound                       |              | F   | 140.6           |              | F   | 536.5           |                    | F   | 133.0           |
| King St/Braddock Rd              | 0.65         | D   | 41.6            | 0.78         | F   | 95.2            | 0.65               | F   | 110.4           |
| Eastbound                        |              | B   | 14.0            |              | B   | 10.3            |                    | A   | 2.2             |
| Westbound                        |              | E   | 60.4            |              | E   | 70.0            |                    | E   | 59.5            |
| Southeastbound                   |              | D   | 37.6            |              | B   | 17.0            |                    | C   | 118.2           |
| northwestbound                   |              | F   | 81.4            |              | F   | 323.6           |                    | F   | 237.2           |
| King St/Kenwood Ave              | 0.58         | B   | 15.1            | 0.47         | B   | 13.6            | 0.45               | B   | 13.4            |
| Southbound                       |              | B   | 18.2            |              | B   | 17.7            |                    | B   | 16.9            |
| Southeastbound                   |              | B   | 17.0            |              | B   | 12.1            |                    | B   | 13.6            |
| northwestbound                   |              | B   | 11.3            |              | B   | 13.7            |                    | B   | 12.1            |
| Braddock Rd/Marlee Way           | 0.38         | A   | 5.4             | 0.43         | A   | 7.1             | 0.28               | A   | 6.1             |
| Eastbound                        |              | A   | 4.3             |              | A   | 5.0             |                    | A   | 3.5             |
| Westbound                        |              | A   | 3.5             |              | A   | 4.8             |                    | A   | 3.5             |
| Southbound                       |              | C   | 23.4            |              | C   | 20.6            |                    | C   | 20.5            |
| Braddock Rd/Quaker Ln            | 0.86         | F   | 85.6            | 0.92         | E   | 70.6            | 0.63               | D   | 45.2            |
| Eastbound                        |              | E   | 60.9            |              | E   | 64.3            |                    | D   | 52.4            |
| Westbound                        |              | B   | 17.6            |              | D   | 48.5            |                    | B   | 19.5            |
| Northbound                       |              | F   | 164.0           |              | E   | 72.7            |                    | E   | 65.0            |
| Southbound                       |              | C   | 28.3            |              | F   | 86.6            |                    | C   | 28.7            |
| Braddock Rd/Kenwood Ave          | 0.89         | B   | 19.3            | 0.7          | B   | 12.4            | 0.59               | B   | 10.7            |
| Eastbound                        |              | C   | 21.9            |              | B   | 14.1            |                    | B   | 11.1            |
| Westbound                        |              | A   | 8.5             |              | A   | 8.2             |                    | A   | 6.8             |
| Northbound                       |              | C   | 34.5            |              | B   | 17.3            |                    | B   | 15.6            |
| Southbound                       |              | B   | 16.8            |              | B   | 15.0            |                    | B   | 15.0            |
| Quaker Ln/Seminary Rd/Janneys Ln | 1.19         | F   | 82.8            | 0.99         | E   | 78.7            | 0.66               | C   | 27.8            |
| Eastbound                        |              | F   | 190.8           |              | F   | 223.4           |                    | D   | 37.3            |
| Westbound                        |              | D   | 44.2            |              | D   | 35.8            |                    | C   | 26.6            |
| Northbound                       |              | E   | 69.0            |              | C   | 27.6            |                    | C   | 22.4            |
| Southbound                       |              | D   | 40.8            |              | D   | 37.5            |                    | C   | 28.1            |
| Quaker Ln/Duke St                | 1.07         | D   | 51.3            | 1.27         | D   | 44.2            | 0.83               | C   | 28.7            |
| Eastbound                        |              | B   | 17.1            |              | E   | 59.6            |                    | B   | 10.4            |
| Westbound                        |              | C   | 51.3            |              | C   | 22.8            |                    | B   | 19.6            |
| Southbound                       |              | E   | 139.6           |              | F   | 80.2            |                    | E   | 79.7            |

Notes:

1. Results are from the HCM module in Synchro
2. Signalized intersection only, does not include service road.

Table 10: Future Left Turn Delays and Queues

| 2020 Baseline Conditions - Left Turn MOEs (Failing Approaches Only) |                  |          |                       |                 |     |                          |                       |                 |     |                          |                       |                 |     |                          |
|---------------------------------------------------------------------|------------------|----------|-----------------------|-----------------|-----|--------------------------|-----------------------|-----------------|-----|--------------------------|-----------------------|-----------------|-----|--------------------------|
| Signalized Intersection Location                                    | Failing Approach | Movement | AM Peak Hour          |                 |     |                          | PM Peak Hour          |                 |     |                          | Saturday Peak Hour    |                 |     |                          |
|                                                                     |                  |          | V/C                   | Delay (sec/veh) | LOS | Queue (ft.) <sup>1</sup> | V/C                   | Delay (sec/veh) | LOS | Queue (ft.) <sup>1</sup> | V/C                   | Delay (sec/veh) | LOS | Queue (ft.) <sup>1</sup> |
| King St/Taylor St.                                                  | Eastbound        | EBTL     | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | 1.00                  | 100.0           | F   | #314                     |
|                                                                     | Northbound       | NBTL     | 0.99                  | 134.0           | F   | #122                     | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| King St/Quaker Lane                                                 | Eastbound        | EBL      | 1.35                  | 257.6           | F   | #630                     | 0.91                  | 108.5           | F   | #387                     | 1.21                  | 200.8           | F   | #552                     |
|                                                                     | Southbound       | SBT      | 1.18                  | 175.6           | F   | #486                     | 2.30                  | 666.1           | F   | #1097                    | 1.18                  | 173.5           | F   | #486                     |
| King St/Braddock Rd                                                 | Northwestbound   | NWT      | 0.81                  | 81.4            | F   | #276                     | 1.53                  | 323.6           | F   | #681                     | 1.33                  | 237.2           | F   | #572                     |
| King St/Kenwood Ave                                                 | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Braddock Rd/Marlee Way                                              | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Braddock Rd/Quaker Ln                                               | Northbound       | NBL      | 0.58                  | 70.5            | E   | 210                      | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
|                                                                     | Northbound       | NBT      | 1.23                  | 174.1           | F   | #978                     | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
|                                                                     | Southbound       | SBTL     | No Failing Approaches |                 |     |                          | 1.06                  | 98.8            | F   | m97                      | No Failing Approaches |                 |     |                          |
| Braddock Rd/Kenwood Ave                                             | -                | -        | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          | No Failing Approaches |                 |     |                          |
| Quaker Ln/Seminary Rd/Janneys Ln                                    | Eastbound        | EBL      | 0.49                  | 29.9            | C   | 107                      | 0.48                  | 25.7            | C   | 101                      | No Failing Approaches |                 |     |                          |
|                                                                     | Eastbound        | EBTR     | 1.37                  | 221.1           | F   | #867                     | 1.46                  | 257.1           | F   | #1066                    | No Failing Approaches |                 |     |                          |
| Quaker Ln/Duke St                                                   | Southbound       | SBLR     | No Failing Approaches |                 |     |                          | 1.01                  | 80.2            | F   | #448                     | No Failing Approaches |                 |     |                          |

Notes:  
 1 - 95th percentile queue length  
 # - 95th percentile volume exceeds capacity, queue may be longer.  
 m - Volume for 95th percentile queue is metered by upstream signal.

As shown in **Table 9**, operations at all of the intersections are expected to deteriorate in year 2020 for all three time periods due to increases in the projected traffic volumes within the study area, as compared to the existing conditions presented in **Table 1**. The King Street / Quaker Lane intersection is anticipated to operate at capacity (LOS E), while the Braddock Road / Quaker Lane and Quaker Lane / Seminary Road / Janneys Lane intersections are expected to operate over capacity (LOS F) during weekday morning peak hour conditions. The King Street / Quaker Lane and King Street / Braddock Road intersections are expected to continue operating above capacity (LOS F) during weekday evening peak hour conditions. Under existing Saturday peak hour conditions, all of the study intersections operate at LOS E or better; however, under future baseline 2020 conditions, the King Street / Taylor Street, King Street / Quaker Lane, and King Street / Braddock Road intersections are anticipated to operate above capacity (LOS F).

## **5. Future Conditions – Conceptual Build Alternatives**

This section describes the evaluation of alternative improvement plans for intersections anticipated to operate above capacity under the future baseline 2020 conditions. Because of its critical location and existing capacity constraints, this evaluation is primarily focused on the complex King Street / Braddock Road / Quaker Lane intersection. A variety of potential conceptual designs was investigated to improve safety and mobility for all modes within this intersection and nearby roadway corridors. The potential concepts that were developed and evaluated in this study include the following:

- Short-term improvements
- Alternatives 1A and 1B: Eastbound dual left at King Street / Quaker Lane and King Street / Braddock Road intersections, westbound dual left at Braddock Road / Quaker Lane intersection, and closure of the service road which runs parallel with King Street
- Alternative 2: Remove Braddock Road segment between Quaker Lane and King Street and closure of the service road which runs parallel with King Street
- Alternative 2A: Same as Alternative 2 with eastbound and westbound dual left at King Street / Quaker Lane intersection. Addition of south-eastbound left lane at King Street / Braddock Road intersection
- Alternative 3: Remove Quaker Lane segment north of Braddock Road and divert the traffic onto Radford Street
- Alternative 3B: Same as Alternative 3 with eastbound dual left at Braddock Road and Radford Street intersection
- Alternative 4: Quaker Lane (southbound) and Radford Street (northbound) functioning as one-way pairs
- Alternatives 5A, 5B, 5C: Modified roundabouts at King Street, Braddock Road and Quaker Lane (oval and circular shapes)
- Alternative 6: Grade-separation at Braddock / Quaker with depressed Braddock Road, passing under Quaker Lane

All of the conceptual designs considered in this evaluation have been developed to accomplish one or more of the following goals:

1. Reduce the number of conflict points.
2. Reduce the number of vehicle stops and periods of delay, while improving intersection operations.
3. Improve safety and mobility for pedestrians and cyclists.
4. Improve signage and lane markings.
5. Develop improvements to reduce vehicular speed to acceptable levels.
6. Enhance transit efficiency and service, which, in turn, can encourage greater use of transit.
7. Improve pedestrian/bike/transit mobility within the study area, while maintaining vehicular level of service.

Traffic operational analyses were performed for each of the Conceptual Alternatives, under future 2020 conditions, with traffic volume projections adjusted according to the geometric or other travel restrictions associated with each concept. For example, in Conceptual Alternative 2 and 2A where a portion of Braddock Road is proposed for closure, traffic was reassigned to use a portion of Quaker Lane and King Street. The following sections describe the findings of the evaluation of each Conceptual Alternative.

### **5.1. Conceptual Alternatives 1A, 1B, and 1Ai**

Conceptual Alternatives 1A and 1B include the addition of left turn lanes in order to increase the capacity at the following critical movements:

- King Street / Quaker Lane intersection - addition of an eastbound left-turn lane along King Street to improve this approach from a single to a dual left-turn lane configuration.
- King Street / Braddock Road intersection- addition of a south-eastbound left-turn lane along King Street to improve this approach from a single to a dual left-turn lane configuration.
- Braddock Road / Quaker Lane intersection- addition of a westbound left-turn lane along Braddock Road to improve this approach from a single to a dual left-turn lane configuration.

The only difference between Conceptual Alternative 1A and 1B is whether the widening along Braddock Road would occur along the north or south edge of Braddock Road in order to accommodate the addition of a second left-turn lane for the westbound Braddock Road to southbound Quaker Lane movement. Under Conceptual Alternative 1A, the necessary Right-of-Way (ROW) for construction of the additional lane would be acquired along the north frontage of Braddock Road, including acquisition of some private property from an existing nursery. On the other hand, for Conceptual Alternative 1B, the necessary ROW would be acquired along the south frontage of Braddock Road, including acquisition of some private property from the Lexus Dealership. The layouts for Conceptual Alternative 1A and 1B are shown in **Figure 7** and **Figure 8**, respectively.

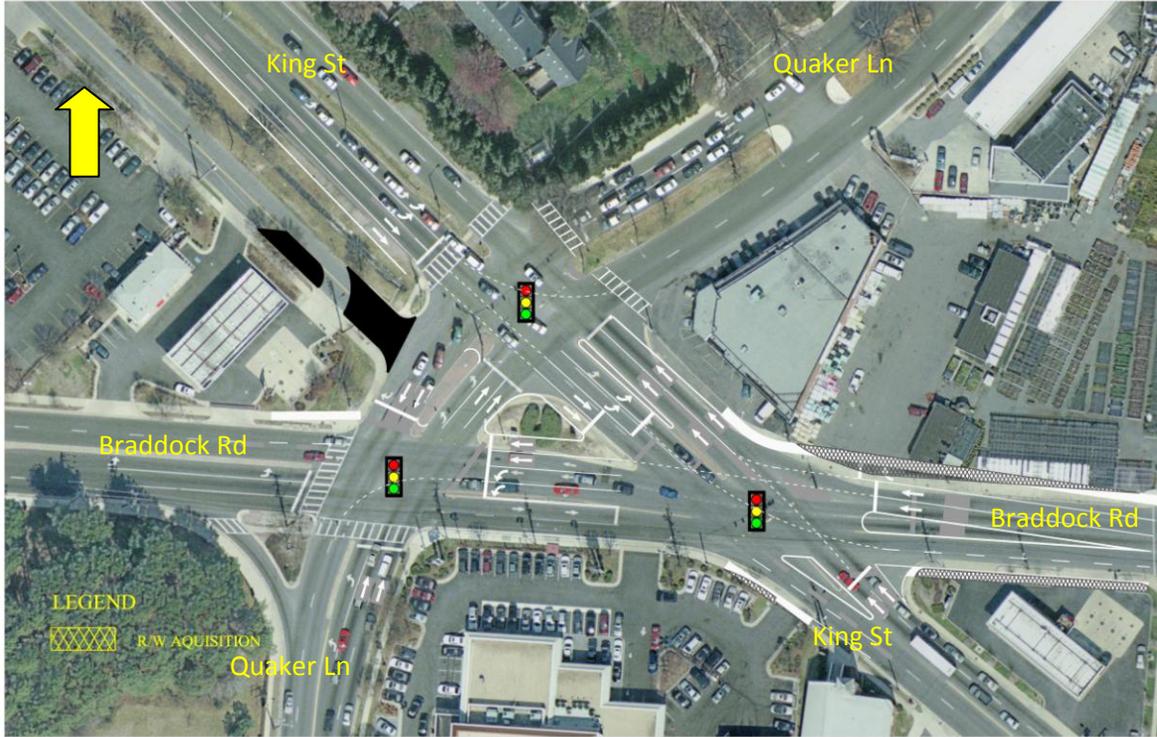


Figure 7: Conceptual Alternative 1A

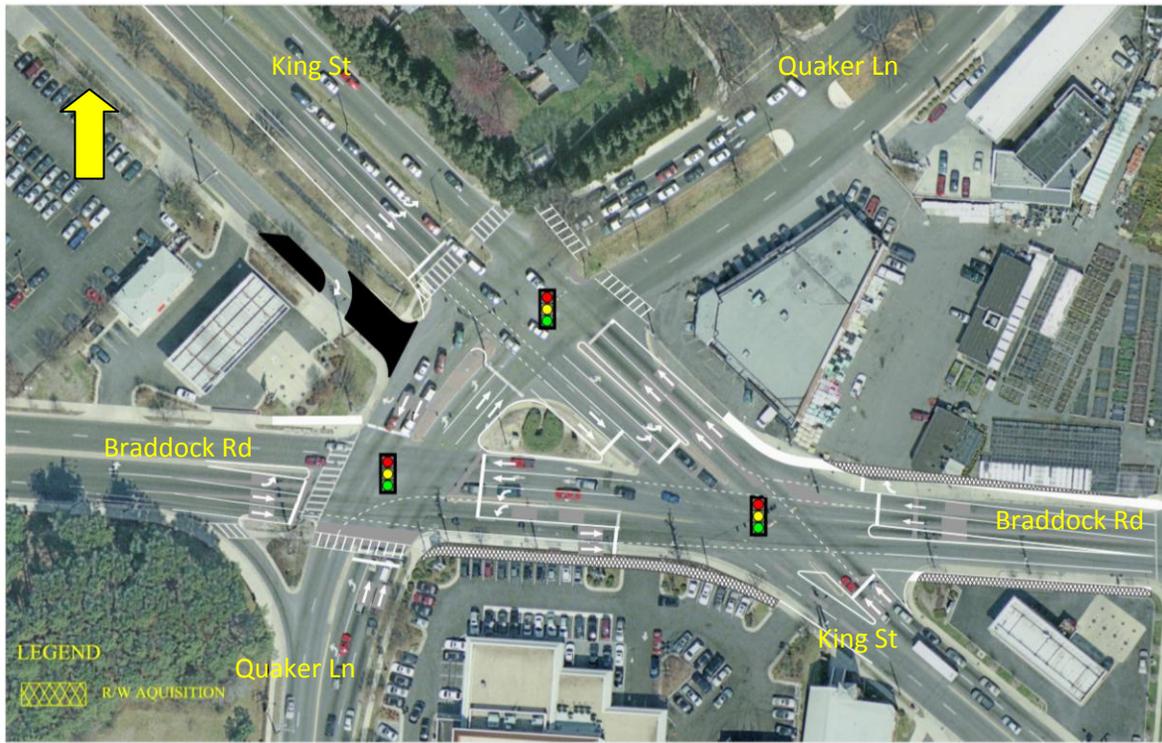


Figure 8: Conceptual Alternative 1B

Error! Reference source not found. presents the Measures of Effectiveness (MOEs) for the intersections that would be affected due to the Conceptual Alternative 1A and 1B improvement for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions. The functional traffic operations of both concepts are considered identical, so the MOE results shown in Error! Reference source not found. would not differ between the two concepts.

**Table 11: 2020 Conditions - Alternative 1A/1B**

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln                | 0.95         | E   | 64.5            | 1.14         | F   | 210.2           | 0.96               | F   | 83.3            |
| King St/Braddock Rd              | 0.57         | D   | 35.7            | 0.73         | F   | 94.8            | 0.54               | E   | 77.6            |
| Braddock Rd/Quaker Ln            | 0.82         | F   | 85.5            | 0.84         | E   | 65.3            | 0.59               | D   | 45.0            |

Under this concept, the overall delay would either be in the similar range or decrease at all three intersections for all time periods compared to 2020 Baseline Conditions. The most noticeable decrease would occur at the Braddock Road / King Street and Quaker Lane / King Street intersections, during the weekday morning and Saturday peak hour conditions, because the addition of a left-turn lane would benefit the heavy left-turn demand volume at these intersections. Projected delay at the Braddock Road / Quaker Lane intersection would not change significantly after construction of the improvements for all time periods and overall MOEs are not anticipated to improve significantly during the weekday evening peak hour.

One additional design variant of Conceptual Alternative 1A was also evaluated. In addition to the improvements described under 1A, *Conceptual Alternative 1Ai* includes the addition of a second northbound left turn lane along Quaker Lane, which would reconfigure the approach from a single to a dual left-turn lane configuration at the intersection of King Street / Quaker Lane, as shown in **Figure 9**. **Table 12** presents the analysis MOEs for the key signalized intersections affected by the Conceptual Alternative 1Ai improvements; under the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

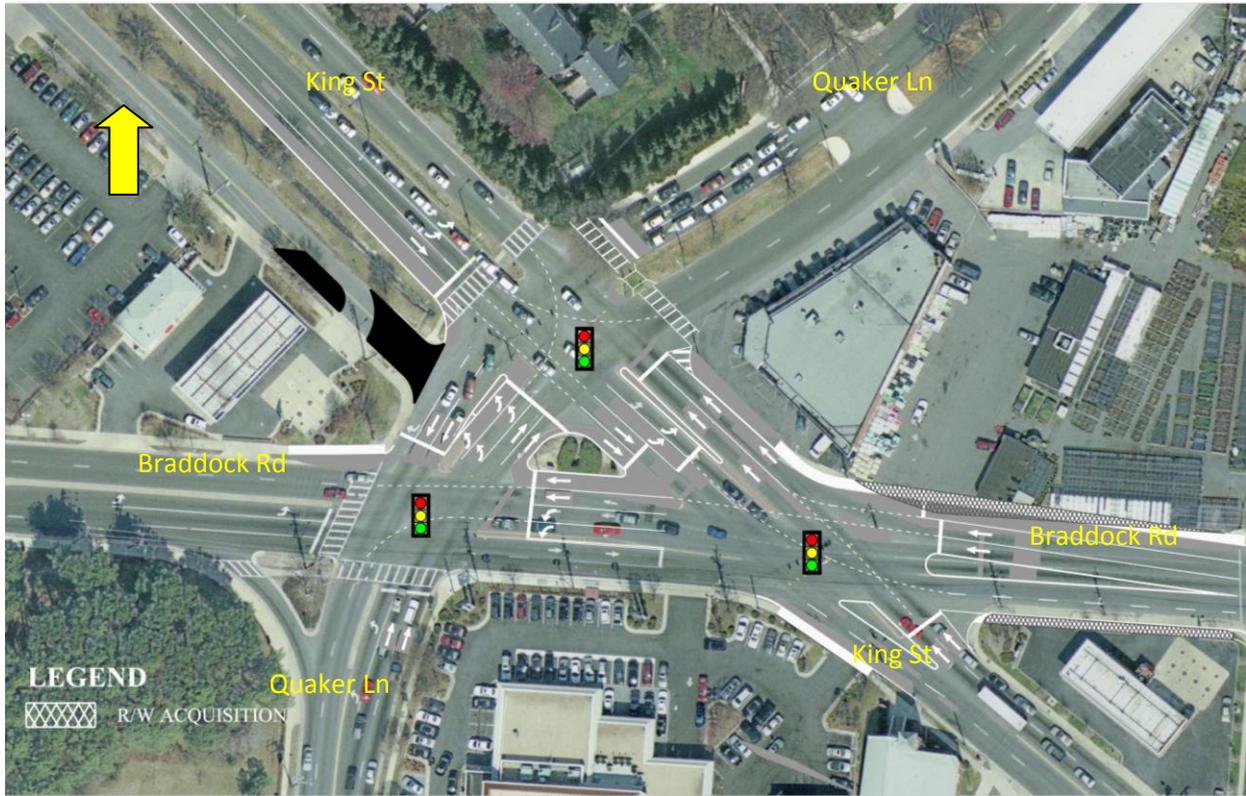


Figure 9: Conceptual Alternative 1Ai

Table 12: 2020 Conditions - Alternative 1Ai

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln                | 0.85         | E   | 63.2            | 1.05         | F   | 209.7           | 0.89               | F   | 82.6            |
| King St/Braddock Rd              | 0.57         | D   | 35.7            | 0.73         | F   | 94.8            | 0.54               | E   | 77.5            |
| Braddock Rd/Quaker Ln            | 0.82         | F   | 85.5            | 0.84         | E   | 65.3            | 0.59               | D   | 45              |

Under this concept, the overall operational performance of the King Street / Quaker Lane intersection shows some slight improvement from the Conceptual Alternative 1A results, during all time periods. Operations at the rest of the study intersections would remain unchanged.

The following is a summary of the key benefits and disadvantages of Conceptual Alternatives 1A, 1B, and 1Ai:

- Benefits
  - Improves capacity for key turn movements which are eastbound left at King Street / Quaker Lane and King Street / Braddock Road intersections and westbound left at Braddock Road / Quaker Lane intersection
  - Reconfiguration does not impede pedestrian mobility.
  - Very little geometric change.
- Disadvantages
  - Involves some ROW impacts, including some private property acquisition.

Therefore, Conceptual Alternatives 1A, 1B, and 1Ai would meet the goal of reducing the number of vehicle stops and periods of delay, while improving intersection operations at these key intersections.

## **5.2. Conceptual Alternatives 2, 2A, and 2Ai**

Conceptual Alternative 2 reduces the number of conflict points by removing the Braddock Road segment between Quaker Lane and King Street as shown in **Figure 10**. Therefore, the previous four-legged intersection at Braddock Road / Quaker Lane and Braddock Road / King Street will function as a three-legged intersection and vehicles that used to travel along this link would be diverted to Quaker Lane and King Street. This configuration would require closing one driveway to the car dealership.

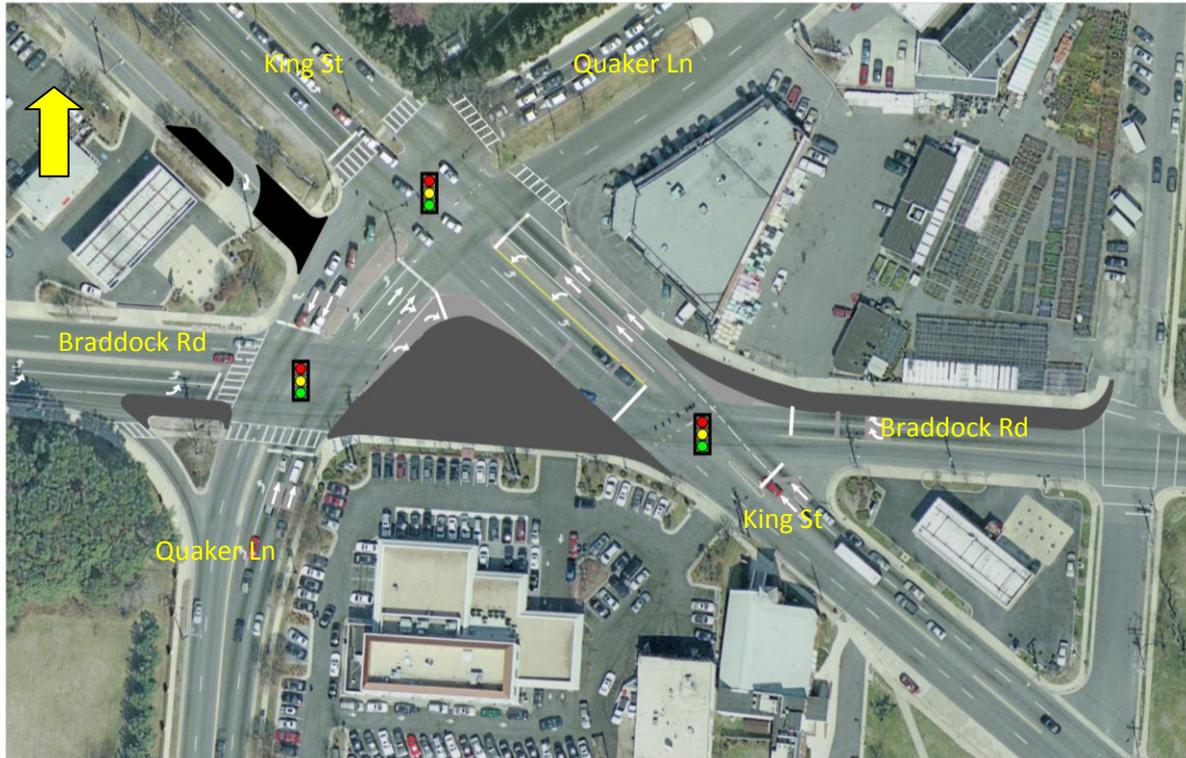


Figure 10: Conceptual Alternative 2

Table 13 present the MOE results for the key signalized intersections that would be affected due to the Conceptual Alternative 2 improvements for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

Table 13: 2020 Conditions - Alternative 2

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln                | 1.02         | F   | 81.1            | 1.24         | F   | 125.3           | 0.87               | D   | 53.4            |
| King St/Braddock Rd              | 0.65         | E   | 59.8            | 0.69         | D   | 36.8            | 0.59               | D   | 48.5            |
| Braddock Rd/Quaker Ln            | 0.84         | F   | 137.7           | 0.80         | F   | 93.6            | 0.60               | E   | 61.9            |

Under this concept, due to the diversion of traffic on the eastbound through movement, vehicular delay is anticipated to increase during weekday morning peak hour conditions for the two remaining study intersections, compared to baseline conditions. However, during the weekday evening and Saturday peak hour conditions, operations at the Braddock Road / King Street and Quaker Lane / King Street intersections are expected to improve, primarily as the result of eliminating some signal phases and

increased green time for the critical intersection movements. Therefore, the benefits obtainable under this concept would vary depending on time of the day and would improve overall operations mainly during weekday evening and Saturday peak hour conditions.

Conceptual Alternative 2A is similar to Concept 2, but as shown in **Figure 11**, includes the addition of left-turn lanes on the following approaches, to increase the capacity of certain critical movements:

- King Street / Quaker Lane intersection - addition of an eastbound and a westbound left-turn lane along King Street, upgrading from a single to a dual left-turn lane configuration.
- King Street / Braddock Road intersection - addition of a south-eastbound left-turn lane along King Street, upgrading from a single to a dual left-turn lane configuration.

**Table 14** presents the MOE results for the key signalized intersections that would be affected due to the Conceptual Alternative 2A improvements for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

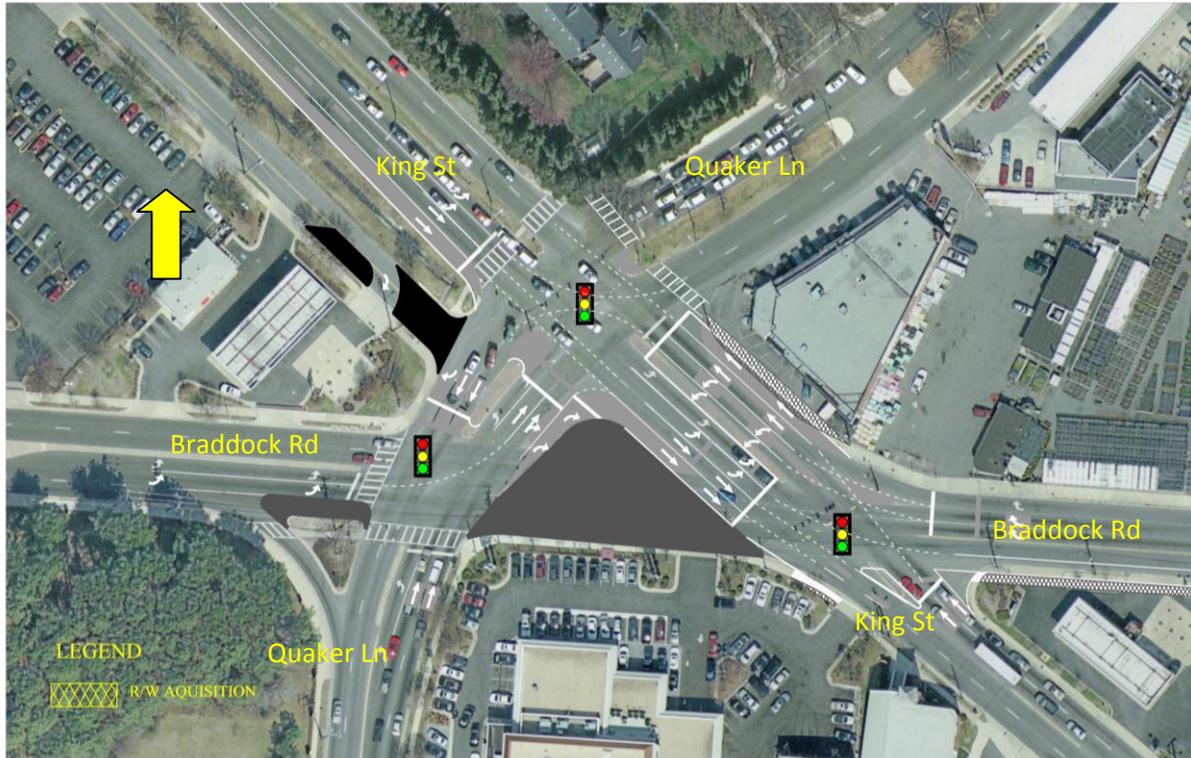


Figure 11: Conceptual Alternative 2A

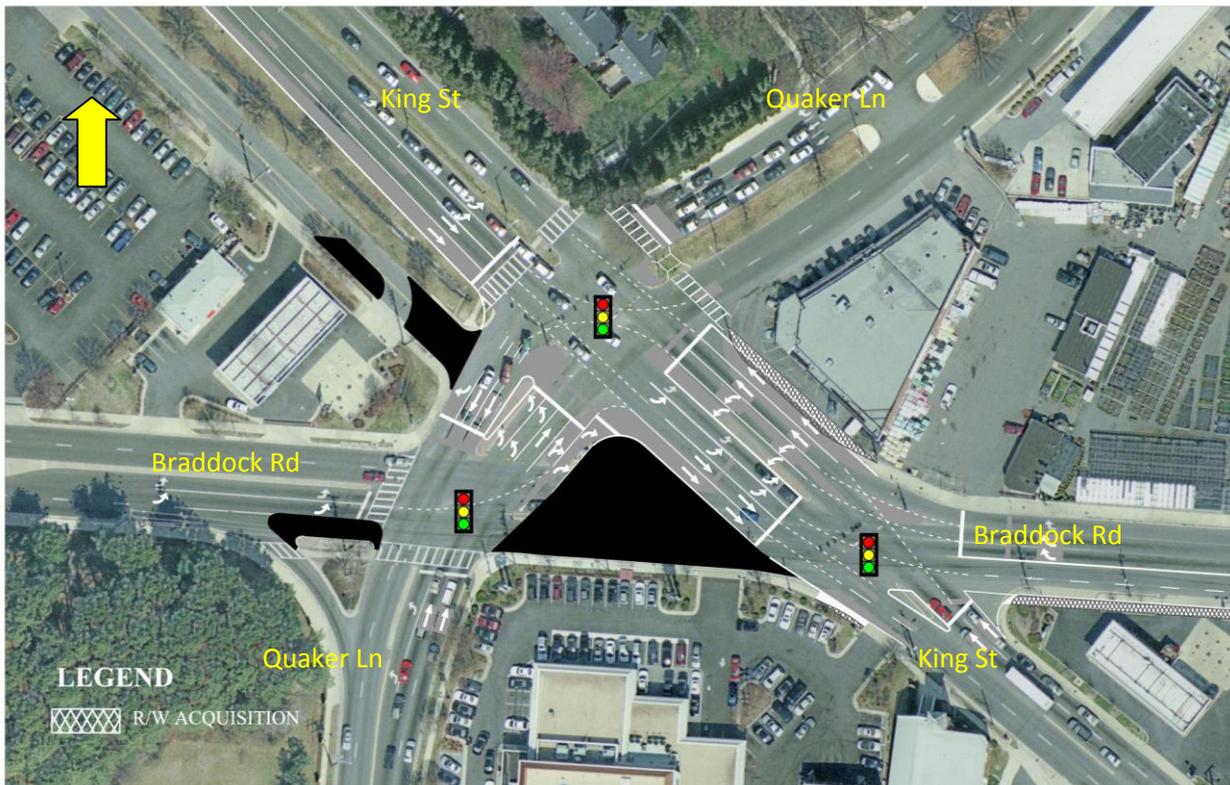
Table 14: 2020 Conditions - Alternative 2A

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln                | 0.87         | E   | 62.5            | 1.04         | F   | 80.1            | 0.76               | D   | 45.8            |
| King St/Braddock Rd              | 0.41         | C   | 27.6            | 0.46         | C   | 27.3            | 0.39               | C   | 31.9            |
| Braddock Rd/Quaker Ln            | 0.81         | F   | 96.7            | 0.74         | E   | 60.2            | 0.56               | D   | 44.7            |

Under this concept, overall intersection delay would decrease at all of the study intersections, during all time periods, except at the Braddock Road / Quaker Lane intersection during the weekday morning peak hour conditions. The operational improvements demonstrated in **Table 14** are due to the increase in capacity associated with the additional left-turn lanes. The most notable delay reduction would be expected at the Quaker Lane / King Street and Braddock Road / King Street intersections during the weekday evening and Saturday peak hour conditions. Anticipated delay at the Braddock Road / Quaker Lane intersection would not change significantly after the improvements for any time periods. The greatest individual movement benefits are expected where additional left-turn lanes are proposed.

Overall, the benefits obtainable under this concept would improve operations during all peak hour conditions at all three subject intersections, with exception of the Braddock Road / Quaker Lane intersection during weekday morning peak hour conditions.

One additional design variant of Conceptual Alternative 2A was also evaluated. In addition to the improvements described under 2A, *Conceptual Alternative 2Ai* proposes a second northbound left-turn lane on Quaker Lane at King Street, which would reconfigure the approach from a single to a dual left turn lane configuration, as shown in **Figure 12**.



**Figure 12: Conceptual Alternative 2Ai**

**Table 15** presents the MOE results for the key signalized intersections that would be affected due to the Conceptual Alternative 2Ai improvements for the 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

Table 15: 2020 Conditions - Alternative 2Ai

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln                | 0.85         | E   | 62.2            | 1.01         | E   | 79.9            | 0.73               | D   | 45.6            |
| King St/Braddock Rd              | 0.41         | C   | 27.6            | 0.46         | C   | 27.3            | 0.39               | C   | 31.9            |
| Braddock Rd/Quaker Ln            | 0.81         | F   | 96.7            | 0.74         | E   | 60.2            | 0.56               | D   | 44.7            |

Under this concept, the overall operational performance would be slightly better than Conceptual Alternative 2A at the intersection of King Street / Quaker Lane during all time periods. Operations at the rest of the study intersections would remain the same during all time periods.

The following is a summary of the key benefits and disadvantages of Conceptual Alternatives 2, 2A, and 2Ai:

- Benefits
  - Improves traffic operations during the weekday evening and Saturday peak hour conditions at the intersections of King Street / Quaker Lane and King Street / Braddock Road.
  - No ROW impacts.
  - Reconfiguration does not impede pedestrian mobility and safety.
  - Minor improvements would reduce number of movements within the intersections, which could improve vehicular safety.
- Disadvantages
  - Greater queuing at the Braddock Road / Quaker Lane intersection may result from signal settings intended to prevent vehicles from blocking the King Street / Quaker Lane intersection.
  - Potential spillback at turn bays due to heavy diverted volume.
  - Reduces accessibility to the business affected by the section of Braddock Road that is closed.
  - Rerouting could increase driver confusion due to multiple turn movements over a short distance.

Therefore, Conceptual Alternatives 2A, 2B, and 2Ai would all meet the goal of reducing the number of conflict points by removing the Braddock Road segment between Quaker Lane and King Street.

However, at Braddock Road / Quaker Lane intersection goal of reducing the number of vehicle stops and periods of delay, while improving intersection operations would not be obtainable.

### 5.3. Conceptual Alternatives 3A and 3B

Conceptual Alternative 3A proposes elimination of an approximately 600 foot segment of Quaker Lane, north of Braddock Road, and diversion of northbound and southbound through traffic from Quaker Lane onto existing Radford Street, as shown in **Figure 13**. The Conceptual Alternative 3B concept is similar to 3A, but includes the additional improvement of the left-turn lanes at Braddock Road and Radford Street intersection, from single to dual left-turn lane configurations, as shown in **Figure 14**. Under both of these alternatives, the previous four-legged intersection of Braddock Road / Quaker Lane would function as a three-legged intersection and the Quaker Lane / King Street intersection would be eliminated. Due to the diversion of traffic from the Quaker Lane elimination, the expanded Braddock Road / Radford Street intersection would need to be signalized, and Radford Street, north of Braddock Road, would presumably be renamed Quaker Street.

**Table 16** and **Table 17** present the MOE results for the key signalized intersections that would be impacted due to the Conceptual Alternatives 3A and 3B improvements for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

**Table 16: 2020 Conditions - Alternative 3A**

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Braddock Rd              | 1.20         | F   | 136.3           | 1.26         | F   | 150.0           | 1.01               | F   | 106.2           |
| Braddock Rd/Quaker Ln South      | 1.15         | F   | 137.2           | 1.39         | F   | 190.4           | 1.12               | F   | 127.9           |
| Braddock Rd/Quaker Ln North*     | 1.03         | F   | 139.9           | 0.93         | F   | 133.7           | 1.28               | F   | 208.0           |
| Braddock Rd/Kenwood Ave          | 0.85         | C   | 22.8            | 0.70         | B   | 16.9            | 0.56               | B   | 12.9            |

\* Quaker Lane North formerly Radford Street.

**Table 17: 2020 Conditions - Alternative 3B**

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Braddock Rd              | 1.20         | F   | 136.3           | 1.26         | F   | 150.0           | 1.01               | F   | 106.2           |
| Braddock Rd/Quaker Ln South      | 1.15         | F   | 137.2           | 1.39         | F   | 190.4           | 1.12               | F   | 127.9           |
| Braddock Rd/Quaker Ln North*     | 0.74         | F   | 111.0           | 0.78         | F   | 126.7           | 0.80               | F   | 92.4            |
| Braddock Rd/Kenwood Ave          | 0.85         | C   | 22.8            | 0.70         | B   | 16.9            | 0.56               | B   | 12.9            |

\* Quaker Lane North formerly Radford Street.

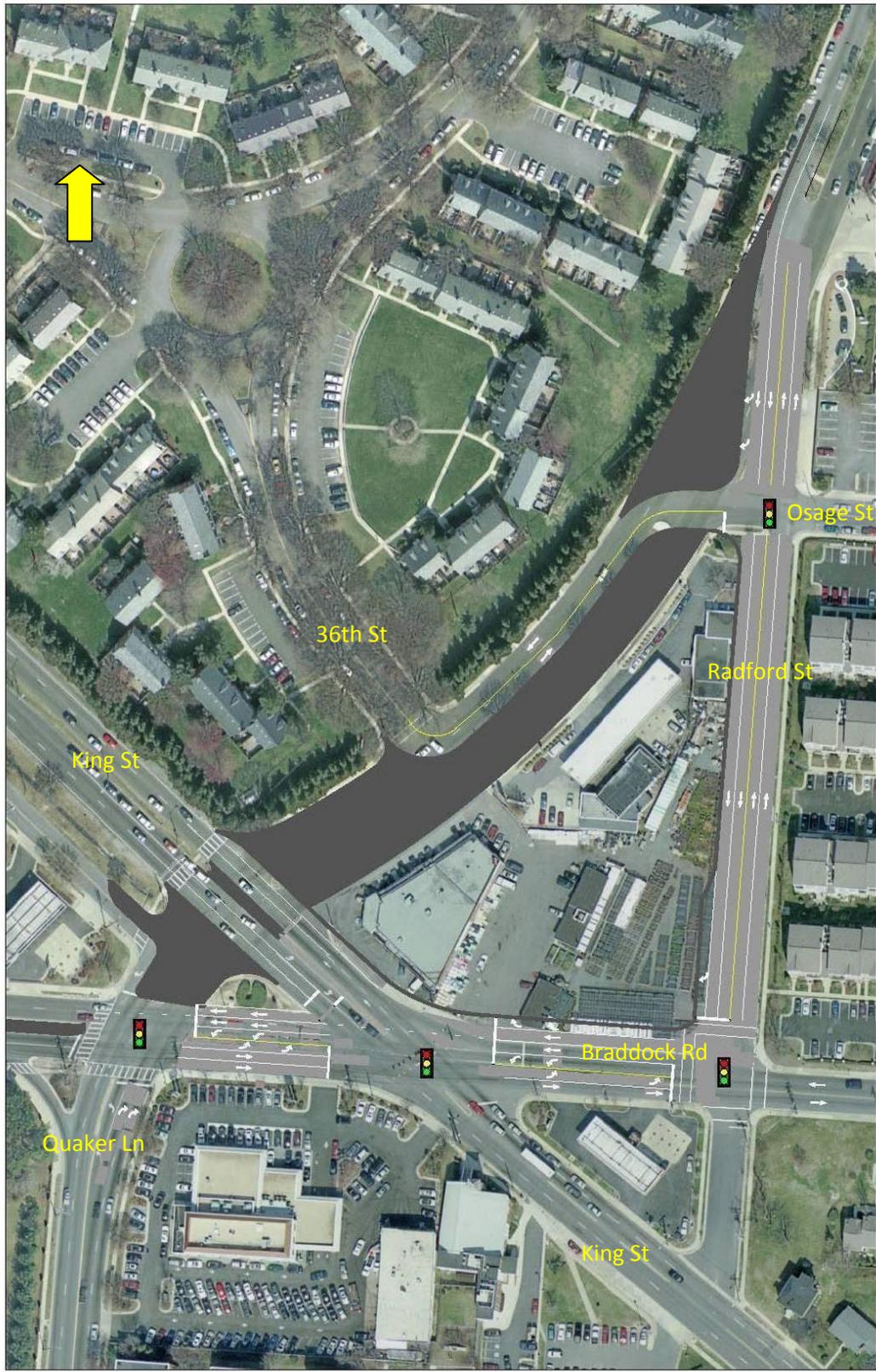


Figure 13: Conceptual Alternative 3A



Figure 14: Conceptual Alternative 3B

As shown in **Table 16** and **Table 17**, diversion of the through traffic from Quaker Lane to Radford Street will cause operational deterioration at the Braddock Road / Quaker Lane and Braddock Road / King Street intersections. Specifically, vehicle delay is expected to increase at these study intersections compared to baseline conditions during both the weekday morning and evening peak hour conditions. However, during Saturday peak hour conditions, operations at the Braddock Road / King Street intersection are expected to improve, due to increased green time for the critical intersection movements. Under Conceptual Alternative 3B only, operations at the Braddock Road / Quaker Lane North intersection (formerly Radford Street) would generally improve because of the dual left-turn lanes proposed at this location. Based on the results shown in **Table 16** and **Table 17**, the benefits obtainable under these concepts would likely be offset by the relatively high construction costs and impacts associated with these extensive improvements.

The following is a summary of the key benefits and disadvantages of Conceptual Alternatives 3A and 3B:

- Benefits
  - Reconfiguration does not significantly impede pedestrian mobility (this concept reduces the number of cross walks by one) and improves safety.
  - Reducing access to service road would likely reduce the number of crashes.
  
- Disadvantages
  - Does not improve traffic operations at most of the study intersections during all peak periods.
  - Involves some ROW impacts, including acquisition of private property to allow for widening of Radford Street.
  - Driver wayfinding is somewhat confusing for the diverted traffic that used to travel along Quaker Lane, especially for drivers using 36th Street who will have to divert to Radford Street.
  - Travel distance will increase for some traffic to access stores within the building at the northeast corner of the Quaker Lane / King Street intersection.

Therefore, Conceptual Alternatives 3A, and 3B would all meet the goal of reducing the number of conflict points by removing the segment along Quaker Lane which used to intersect with King Street. However at King Street / Braddock Road and Braddock Road / Quaker Lane (north and south) intersections, goal of reducing the number of vehicle stops and periods of delay, while improving intersection operations would not be obtainable.

### 5.4. Conceptual Alternative 4

For Conceptual Alternative 4, the current two-way operations along both Quaker Lane and Radford Street would be modified to provide southbound-only travel on Quaker Lane and northbound-only travel on Radford Street, for approximately 600 feet to the north of Braddock Road. The two roadways would then function as one-way pairs, as shown in **Figure 15**. Under this alternative, a number of conflicting movements would be eliminated and signal green time for the remaining phases would increase. As a result of diverting traffic from Quaker Lane to Radford Street, the Braddock Road / Radford Street intersection would need to be signalized and Radford Street would need to be improved by widening the travel lanes and providing curb and sidewalks.

**Table 18** presents the MOE results for the key signalized intersections that would be impacted due to the Conceptual Alternative 4 for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

**Table 18: 2020 Conditions - Alternative 4**

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln SB             | 0.45         | D   | 54.5            | 0.64         | F   | 106.9           | 0.48               | D   | 38.3            |
| King St/Braddock Rd              | 0.92         | E   | 77.3            | 0.88         | E   | 62.2            | 0.78               | E   | 73.3            |
| King St/Quaker Ln NB             | 0.62         | C   | 34.1            | 0.57         | C   | 29.6            | 0.52               | C   | 28.7            |
| Braddock Rd/Quaker Ln NB         | 1.18         | F   | 136.5           | 1.07         | F   | 154.8           | 1.01               | F   | 110.9           |
| King St/Kenwood Ave              | 0.56         | B   | 10.4            | 0.47         | B   | 17.1            | 0.45               | A   | 8.1             |
| Braddock Rd/Quaker Ln SB         | 0.59         | D   | 43.2            | 0.75         | D   | 45.3            | 0.46               | C   | 31.3            |
| Braddock Rd/Kenwood Ave          | 0.85         | C   | 23.1            | 0.7          | B   | 16.9            | 0.56               | B   | 12.9            |

As shown in **Table 18**, the re-routing of northbound Quaker Lane traffic as a result of the one-way pair concept design results in improvement in the operation of the three closely spaced intersections. Specifically, vehicular delay is expected to decrease at these intersections, compared to baseline conditions, during all peak hour conditions. The only exception is the Braddock Road / King Street intersection, which is anticipated to experience some operation deterioration during the weekday morning peak hour due to an increase in diverted traffic volume. However, the overall operational benefits of the entire network under this concept would be significant compared to other conceptual alternatives.

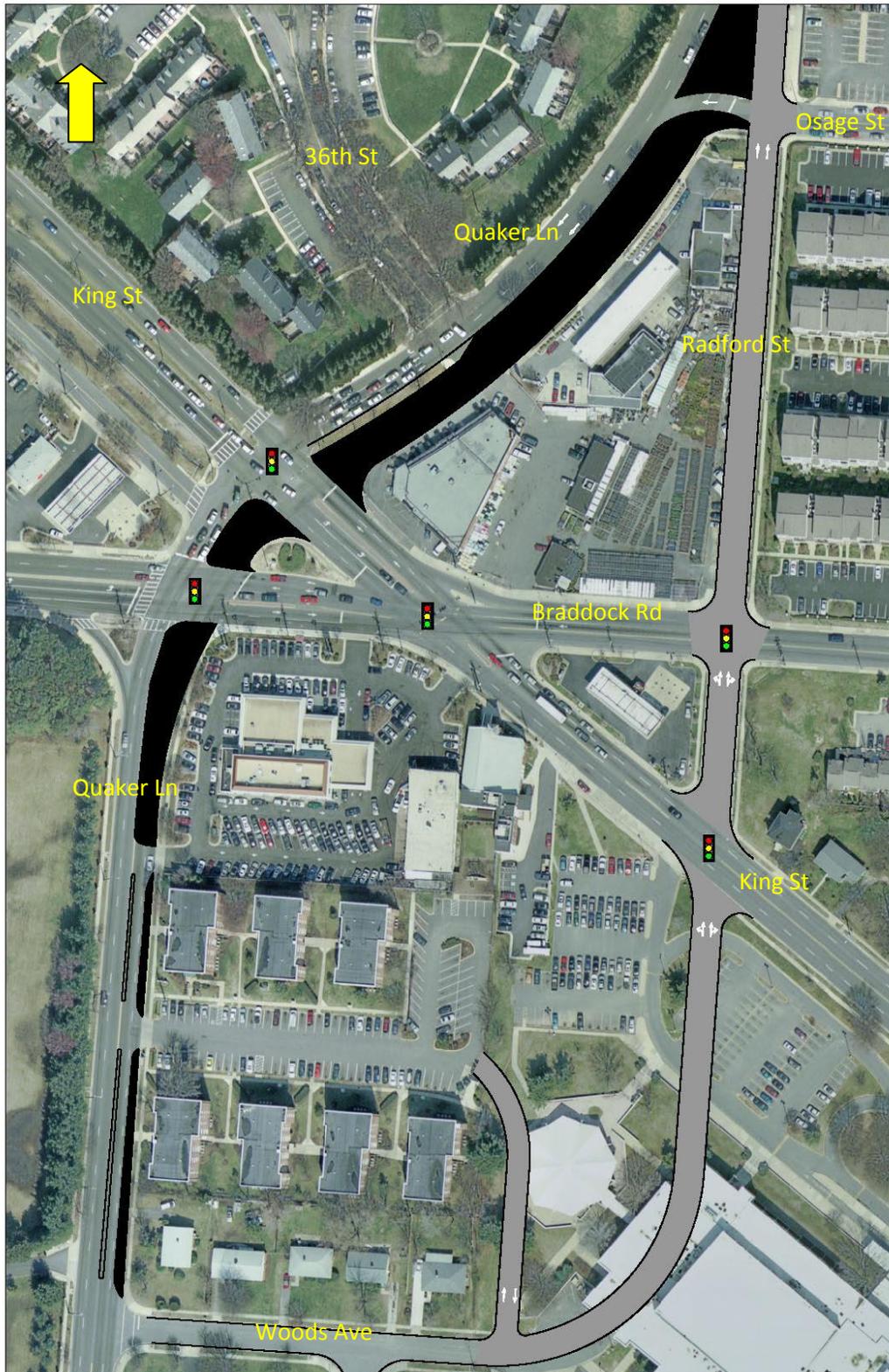


Figure 15: Conceptual Alternative 4

The following is a summary of the key benefits and disadvantages of Conceptual Alternative 4:

- Benefits
  - Improves traffic operations at all of the study intersections during all time periods, except at the King Street / Braddock Road intersection during weekday morning peak hour conditions.
  - Less potential conflict points due to one way operations at some streets.
  - Reconfiguration would provide shorter crosswalks at many locations, generally improving mobility and safety for pedestrians.
  
- Disadvantages
  - Increased travel distance for some vehicles to reach some destinations.
  - Driver wayfinding could be confusing to traffic that is re-routed due to one-way operations.
  - Involves some ROW impacts, including acquisition of private property to allow for widening of Radford Street.
  - Potential impacts to property use at the TC Williams High School, as the proposed roadway would bisect a portion of the school grounds.

Therefore, Conceptual Alternatives 4 would meet the goal of reducing the number of conflict points due to one way operations at some streets. Also, goal of reducing the number of vehicle stops and periods of delay, while improving intersection operations would be obtainable except at King Street / Braddock Road intersection. In addition, goal of improving safety and mobility for pedestrians and cyclists would be met with the reduction of crosswalk distance.

### **5.5. Conceptual Alternatives 5A, 5B, and 5C**

Conceptual Alternatives 5A, 5B, and 5C involve a massive reconfiguration of the existing intersections to provide various roundabout designs. The configurations include a combination of either a large circular (Conceptual Alternative 5A), small circular (Conceptual Alternative 5B) or oval-shaped roundabout (Conceptual Alternative 5C) as shown in **Figure 16**, **Figure 17**, and **Figure 18** respectively. Roundabouts allow for continuous entry and exit movements through the intersection by providing a series of merge locations along the perimeter of the roundabout. Vehicles entering the roundabout are required to yield to traffic already within the roundabout (which has the right-of-way).

**Table 19** and **Table 20** present the MOE results of the various roundabout concepts for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

The heavy traffic volumes result in significant delay for all roundabout concepts during all three peak hours. Therefore, the benefits obtainable under these concepts would be offset by the extensive disruption and costs required to construct any of the roundabout concepts. Also, since conceptual

alternative 5C which has similar configuration as that of 5B, was resulting in significant delay, conceptual alternative results for 5B was not analyzed per direction from the City.

The following is a summary of the key benefits and disadvantages of Conceptual Alternatives 5A, 5B, and 5C:

- Benefits
  - Eliminates need for signalized intersections.
  - Roundabouts typically reduce crash severity by reducing vehicle speeds.
  
- Disadvantages
  - Roundabouts typically experience poorer operations than traffic signals under high traffic volume conditions; analysis supports conclusion that roundabout concepts will increase vehicular delay compared to non-roundabout alternatives.
  - Extensive ROW acquisition and complete reconfiguration of the intersection approaches to the Braddock Road / King Street / Quaker Lane area would be required.
  - Driver wayfinding would possibly be confusing and potential risk of increase in number of crashes with the roundabout configuration.
  - Pedestrian flow would be negatively impacted because roundabouts do not typically provide protected pedestrian signal phases and travel distance around the roundabouts would be greater than non-roundabout alternatives.

Therefore, Conceptual Alternatives 5A, 5B, and 5C would meet the goal of reducing the number of conflict points with the roundabout operations. Also, goal of reducing vehicular speed to acceptable levels can be met under this geometric configuration. However, goal of reducing the number of vehicle stops and periods of delay, while improving intersection operations would not be obtainable. In addition, goal of improving safety and mobility for pedestrians and cyclists would not be met.

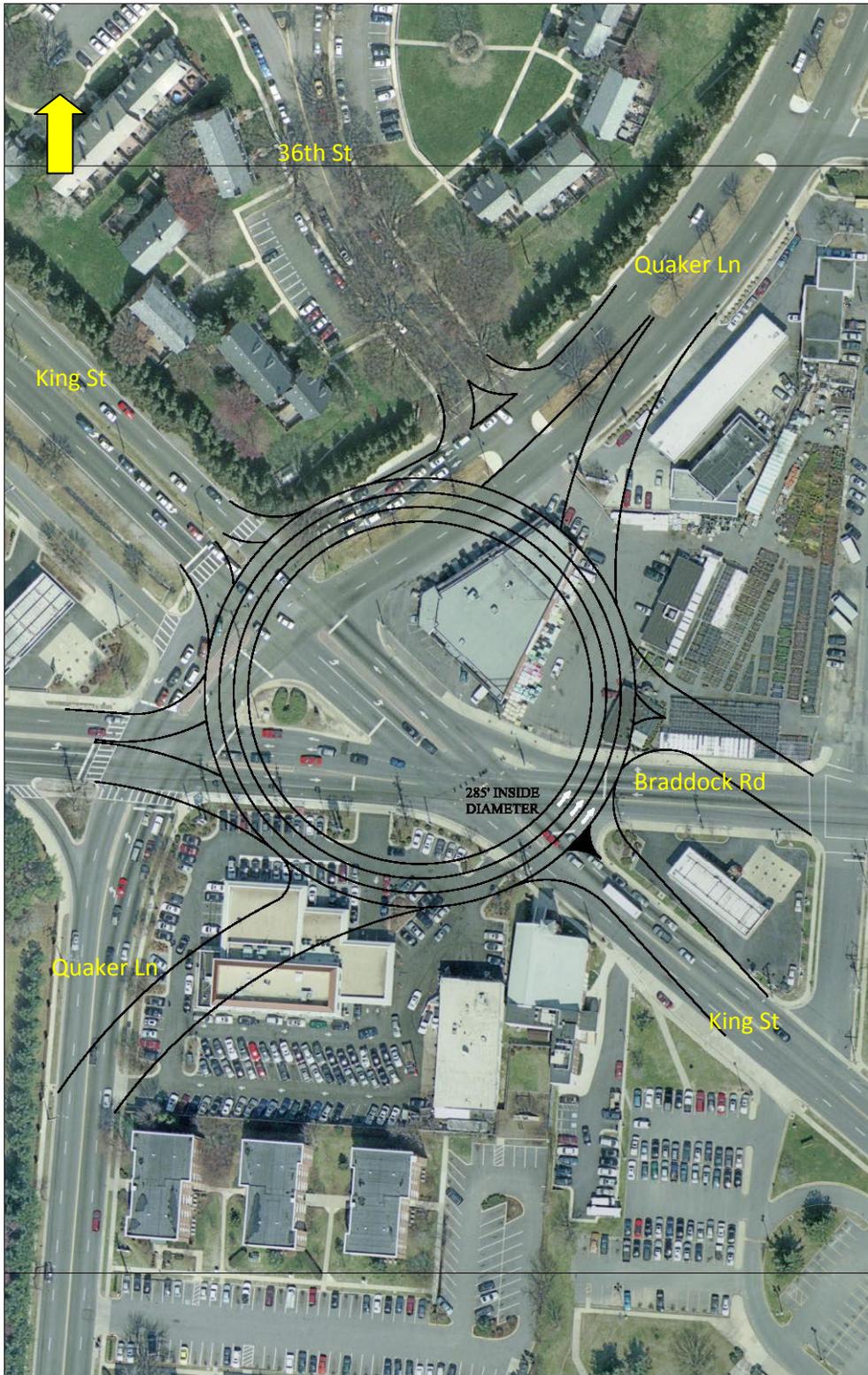


Figure 16: Conceptual Alternative 5A

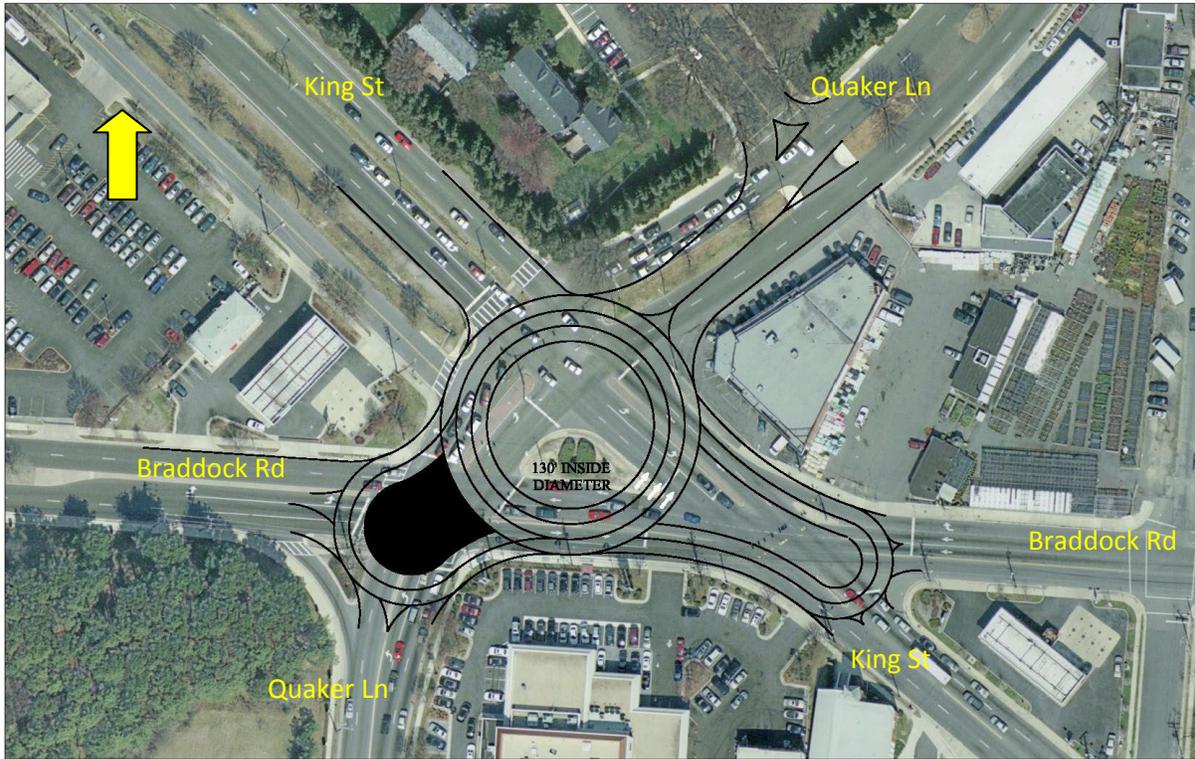


Figure 17: Conceptual Alternative 5B

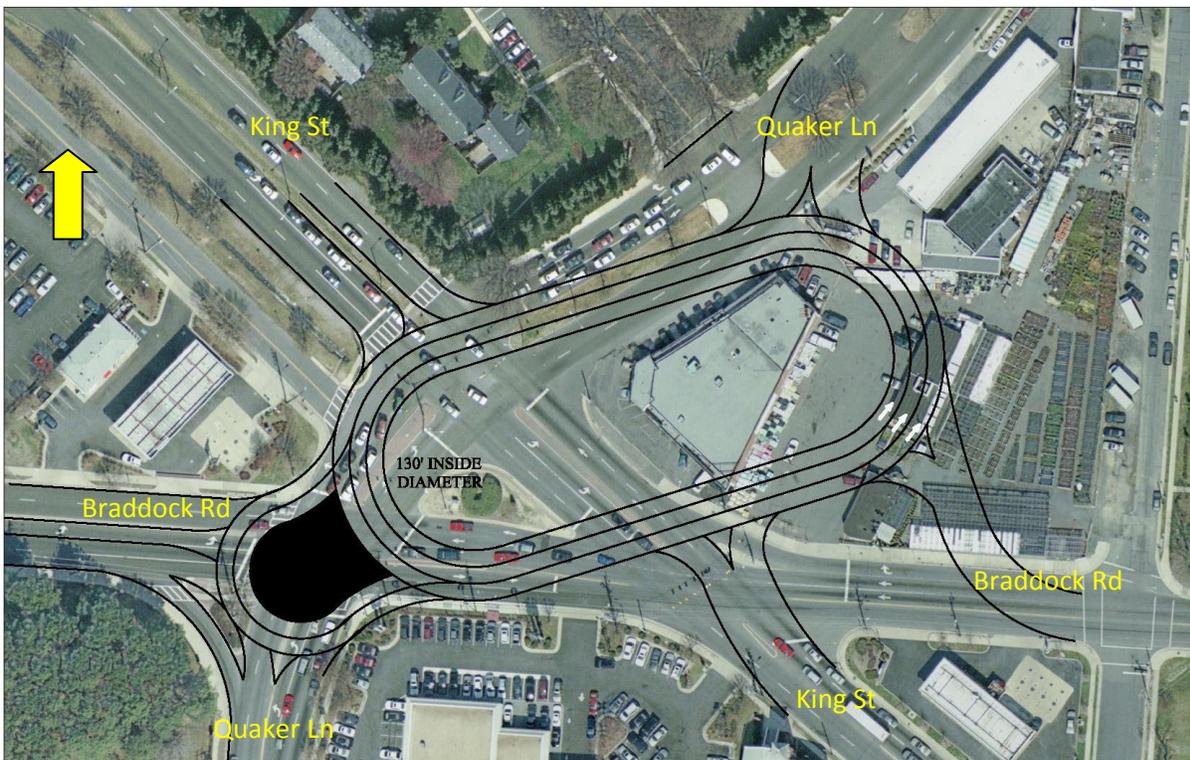


Figure 18: Conceptual Alternative 5C

Table 19: 2020 Conditions - Conceptual Alternative 5A

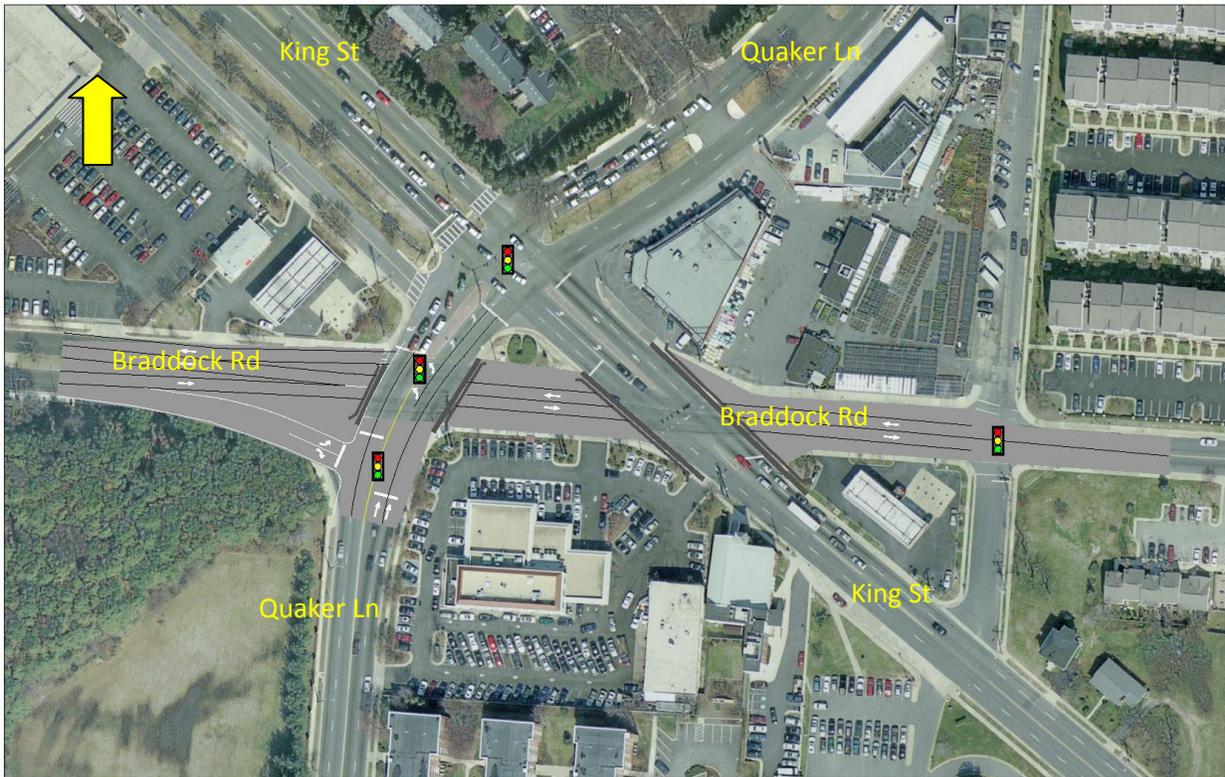
| Unsignalized Intersection Location | AM Peak Hour                                                |                      |                    |                            |                          | PM Peak Hour   |                      |                    |                            |                          | Saturday Peak Hour |                      |                    |                            |                          |
|------------------------------------|-------------------------------------------------------------|----------------------|--------------------|----------------------------|--------------------------|----------------|----------------------|--------------------|----------------------------|--------------------------|--------------------|----------------------|--------------------|----------------------------|--------------------------|
|                                    | Worst Approach                                              | Worst Approach Delay | Worst Approach LOS | Overall Intersection Delay | Overall Intersection LOS | Worst Approach | Worst Approach Delay | Worst Approach LOS | Overall Intersection Delay | Overall Intersection LOS | Worst Approach     | Worst Approach Delay | Worst Approach LOS | Overall Intersection Delay | Overall Intersection LOS |
| Quaker Ln North                    | North                                                       | 180.0                | F                  | 38.0                       | E                        | North          | 722.9                | F                  | 239.6                      | F                        | North              | 164.7                | F                  | 40.8                       | E                        |
| King St West                       | West                                                        | 212.0                | F                  | 70.6                       | E                        | West           | 575.4                | F                  | 158.9                      | F                        | West               | 164.3                | F                  | 57.7                       | E                        |
| Braddock Rd West                   | West                                                        | 450.5                | F                  | 140.4                      | F                        | West           | 777.8                | F                  | 197.5                      | F                        | West               | 167.4                | F                  | 33.9                       | D                        |
| Quaker Ln South                    | South                                                       | 823.9                | F                  | 256.8                      | F                        | South          | 410.3                | F                  | 93.6                       | F                        | South              | 224.5                | F                  | 62.0                       | E                        |
| King St East                       | South                                                       | 149.9                | F                  | 14.6                       | E                        | South          | 226.4                | F                  | 44.2                       | E                        | South              | 126.3                | F                  | 24.5                       | D                        |
| Braddock Rd East                   | Intersection sign configuration not allowed in HCM Analysis |                      |                    |                            |                          |                |                      |                    |                            |                          |                    |                      |                    |                            |                          |

Table 20: 2020 Conditions – Conceptual Alternative 5C

| Unsignalized Intersection Location              | AM Peak Hour                                                |                      |                    |                            |                          | PM Peak Hour   |                      |                    |                            |                          | Saturday Peak Hour |                      |                    |                            |                          |
|-------------------------------------------------|-------------------------------------------------------------|----------------------|--------------------|----------------------------|--------------------------|----------------|----------------------|--------------------|----------------------------|--------------------------|--------------------|----------------------|--------------------|----------------------------|--------------------------|
|                                                 | Worst Approach                                              | Worst Approach Delay | Worst Approach LOS | Overall Intersection Delay | Overall Intersection LOS | Worst Approach | Worst Approach Delay | Worst Approach LOS | Overall Intersection Delay | Overall Intersection LOS | Worst Approach     | Worst Approach Delay | Worst Approach LOS | Overall Intersection Delay | Overall Intersection LOS |
| Quaker Ln North                                 | North                                                       | 511.6                | F                  | 108.1                      | E                        | North          | ERR                  | F                  | 3313.5                     | F                        | North              | 376.2                | F                  | 93.1                       | D                        |
| King St West                                    | West                                                        | 212.0                | F                  | 70.6                       | E                        | West           | 575.4                | F                  | 158.9                      | F                        | West               | 164.3                | F                  | 57.7                       | E                        |
| Split to Braddock Rd West and Quaker Ln South   | Intersection sign configuration not allowed in HCM Analysis |                      |                    |                            |                          |                |                      |                    |                            |                          |                    |                      |                    |                            |                          |
| Braddock Rd West                                | West                                                        | 295.1                | F                  | 124.4                      | E                        | West           | 705.2                | F                  | 225.4                      | F                        | West               | 43.8                 | E                  | 12.9                       | B                        |
| Quaker Ln South                                 | Intersection sign configuration not allowed in HCM Analysis |                      |                    |                            |                          |                |                      |                    |                            |                          |                    |                      |                    |                            |                          |
| Merge from Braddock Rd West and Quaker Ln South | Intersection sign configuration not allowed in HCM Analysis |                      |                    |                            |                          |                |                      |                    |                            |                          |                    |                      |                    |                            |                          |
| King St East                                    | South                                                       | 149.9                | F                  | 14.6                       | E                        | South          | 226.4                | F                  | 44.2                       | E                        | South              | 126.3                | F                  | 24.5                       | D                        |
| Braddock Rd East                                | South                                                       | 431.1                | F                  | 105.3                      | E                        | South          | 337.7                | F                  | 83.6                       | E                        | South              | 200.2                | F                  | 45.8                       | D                        |

### 5.6. Conceptual Alternative 6

Conceptual Alternative 6 involves the construction of a grade-separated interchange, with Braddock Road would be depressed beneath both Quaker Lane and King Street. The existing intersections of Braddock Road / Quaker Lane and Braddock Road / King Street would be eliminated and ramp connections would be provided between the Braddock Road and Quaker Lane as shown in **Figure 19**.



**Figure 19: Conceptual Alternative 6**

**Table 21** present the MOEs for the key signalized intersections that would be affected due to the Conceptual Alternative 6 improvements for the future 2020 weekday morning, weekday evening, and Saturday peak hour conditions.

**Table 21: 2020 Conditions - Alternative 6**

| Signalized Intersection Location | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| King St/Quaker Ln                | 0.98         | E   | 75.2            | 1.12         | F   | 198.7           | 1.00               | F   | 116.1           |
| King St/Kenwood Ave              | 0.63         | B   | 10.5            | 0.65         | B   | 18.3            | 0.44               | B   | 14.2            |
| Braddock Rd/Kenwood Ave          | 1.01         | D   | 49.1            | 0.89         | D   | 41.5            | 0.70               | C   | 20.9            |
| Braddock Rd/Quaker Ln WB Ramp    | 0.62         | B   | 10.4            | 0.60         | B   | 17.2            | 0.49               | A   | 4.6             |
| Braddock Rd/Quaker Ln EB Ramp    | 0.78         | D   | 54.0            | 0.48         | D   | 49.6            | 0.56               | D   | 36.3            |

As shown in **Table 21**, operations at the King Street / Quaker Lane intersection would improve with reduced delay for weekday morning and evening peak hour conditions, while Saturday peak hour conditions would deteriorate when compared with the operations for the Baseline Conditions. Additionally, the two currently failing intersections of Braddock Road / Quaker Lane and Braddock Road / King Street would be entirely eliminated, reducing a major source of congestion in the study area. Therefore, the benefits obtainable under this concept would be significant, though extensive improvements would be needed to depress Braddock Road to provide grade separation of the major roadways.

The following is a summary of the key benefits and disadvantages of Conceptual Alternative 6:

- Benefits
  - Significant improvement in traffic operations for the weekday morning and evening peak hour conditions would result with this Alternative.
  - Reducing number of intersections would minimize vehicle conflict points and generally improve vehicular safety.
  
- Disadvantages
  - Reduces accessibility to businesses and other properties affected by the depressed section of Braddock Rd.
  - Major design challenges to provide acceptable ramp and overpass grading.
  - Impacts of interchange design and operation could affect other roadways, including Radford Street, which is currently a school bus route.
  - Vastly changes the character of the existing community by reducing pedestrian connectivity and encouraging higher vehicle speeds on Braddock Road.
  - Reconfiguration would require relocation of crosswalks along Quaker Lane and could contribute to pedestrian confusion or difficulty.

Therefore, Conceptual Alternative 6 would meet the goal of reducing the number of conflict points and also the goal of reducing the number of vehicle stops and periods of delay, while improving intersection operations would. However, under this configuration, goal of improving safety and mobility for pedestrians and cyclists would not be met.

### **5.7. Capacity Analysis Summary**

VHB has conducted capacity analyses for six major improvement conceptual alternatives for the Braddock Road / King Street/ Quaker Lane intersection, as well as additional variants of those conceptual alternatives. **Table 22** summarizes the comparison between 2020 baseline, 1A/B, 1Ai, 2A, and 2Ai alternatives.

Based on the results of these capacity analyses, and feedback from both the City and members of the surrounding community that attended the second public meeting, two of the design alternatives were selected for greater focus and additional analysis. The options selected for additional detailed consideration included:

1. **Alternatives 1A/B and 1Ai:** construction of dual left-turn lanes at multiple locations.
2. **Alternatives 2A and 2Ai:** Remove Braddock Road segment between Quaker Lane and King Street and construct dual left-turn lanes on multiple critical movements within the intersections.

The capacity analysis indicates that both of these alternatives could provide substantial operational benefits, during multiple peak hour time periods, without major impacts to private property. While the capacity analysis also indicates that some of the unselected alternatives may provide even greater operational improvement than the selected alternatives, the former would also result in significant impacts to private property and permanently affect the access to multiple existing businesses. During the second public meeting, comments from members of the community indicated that the other concepts were also too intrusive; could decrease public mobility; would have significant impacts on residential areas; and would not provide sufficient safety-related improvements to be considered for implementation. Additionally, some citizens felt that some of the alternatives would be confusing for many drivers, which could impede traffic operations.

Table 22: 2020 Conditions - Comparison Among the Alternatives

| Signalized Intersection Location           | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|--------------------------------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|                                            | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| <b>2020 Conditions - Baseline</b>          |              |     |                 |              |     |                 |                    |     |                 |
| King St/Quaker Ln                          | 1.03         | E   | 78.9            | 1.14         | F   | 212.2           | 0.96               | F   | 92.2            |
| King St/Braddock Rd                        | 0.65         | D   | 41.6            | 0.78         | F   | 95.2            | 0.65               | F   | 110.4           |
| Braddock Rd/Quaker Ln                      | 0.86         | F   | 85.8            | 0.92         | E   | 70.6            | 0.63               | D   | 45.2            |
| <b>2020 Conditions - Alternative 1A/1B</b> |              |     |                 |              |     |                 |                    |     |                 |
| King St/Quaker Ln                          | 0.95         | E   | 64.5            | 1.14         | F   | 210.2           | 0.96               | F   | 83.3            |
| King St/Braddock Rd                        | 0.57         | D   | 35.7            | 0.73         | F   | 94.8            | 0.54               | E   | 77.6            |
| Braddock Rd/Quaker Ln                      | 0.82         | F   | 85.5            | 0.84         | E   | 65.3            | 0.59               | D   | 45              |
| <b>2020 Conditions - Alternative 1Ai</b>   |              |     |                 |              |     |                 |                    |     |                 |
| King St/Quaker Ln                          | 0.85         | E   | 63.2            | 1.05         | F   | 209.7           | 0.89               | F   | 82.6            |
| King St/Braddock Rd                        | 0.57         | D   | 35.7            | 0.73         | F   | 94.8            | 0.54               | E   | 77.5            |
| Braddock Rd/Quaker Ln                      | 0.82         | F   | 85.5            | 0.84         | E   | 65.3            | 0.59               | D   | 45              |
| <b>2020 Conditions - Alternative 2</b>     |              |     |                 |              |     |                 |                    |     |                 |
| King St/Quaker Ln                          | 1.02         | F   | 81.1            | 1.24         | F   | 125.3           | 0.87               | D   | 53.4            |
| King St/Braddock Rd                        | 0.65         | E   | 59.8            | 0.69         | D   | 36.8            | 0.59               | D   | 48.5            |
| Braddock Rd/Quaker Ln                      | 0.84         | F   | 137.7           | 0.8          | F   | 93.6            | 0.6                | E   | 61.9            |
| <b>2020 Conditions - Alternative 2A</b>    |              |     |                 |              |     |                 |                    |     |                 |
| King St/Quaker Ln                          | 0.87         | E   | 62.5            | 1.04         | F   | 80.1            | 0.76               | D   | 45.8            |
| King St/Braddock Rd                        | 0.41         | C   | 27.6            | 0.46         | C   | 27.3            | 0.39               | C   | 31.9            |
| Braddock Rd/Quaker Ln                      | 0.81         | F   | 96.7            | 0.74         | E   | 60.2            | 0.56               | D   | 44.7            |
| <b>2020 Conditions - Alternative 2Ai</b>   |              |     |                 |              |     |                 |                    |     |                 |
| King St/Quaker Ln                          | 0.85         | E   | 62.2            | 1.01         | E   | 79.9            | 0.73               | D   | 45.6            |
| King St/Braddock Rd                        | 0.41         | C   | 27.6            | 0.46         | C   | 27.3            | 0.39               | C   | 31.9            |
| Braddock Rd/Quaker Ln                      | 0.81         | F   | 96.7            | 0.74         | E   | 60.2            | 0.56               | D   | 44.7            |

## **6. Traffic Simulation Analysis**

Micro-simulation traffic analysis was performed using the CORSIM software package (Version 6, Build 10). This micro-simulation analysis was conducted as a supplement HCM output results obtained from Synchro analysis and is intended to examine both how the operations and traffic flow of one of individual intersections affect adjacent intersections and how traffic moves through the system as a whole.

Synchro is a discrete, location-based analysis tool that is based on the deterministic traffic relationships but that does not actually model interactions among vehicles or “track” individual vehicle movements. Synchro also does not account for effects of traffic flow at adjacent intersections. On the other hand, CORSIM is a microscopic simulation model, which simulates the movement of individual vehicles, lane changing, and more accurately represents highly congested conditions, accounts for queue spillbacks affecting upstream intersections and appropriately quantifies resulting reduction of throughput for atypical traffic situations. CORSIM accurately accounts for other factors including closely spaced intersections, complex phasing and non-traditional signal systems operation, and as a whole, the CORSIM program carries these functions across the entire system being modeled to determine the system-wide impacts.

Therefore, for the three study area intersections that are closely spaced, factors such as progression, queue spillback, and bottlenecks at one intersection would directly affect the operations at the adjacent intersections. To address these factors, the HCM analysis was supplemented with CORSIM. The study area for the micro-simulation analysis focuses mainly on the three closely spaced intersections of King Street / Quaker Lane, Braddock Road / Quaker Lane, and Braddock Road / King Street. Alternatives 1 and 2 were selected for further evaluation based on the results of the capacity analyses (provided in the previous chapter), comments received from members of the community during the second public meeting, and consultation with the City of Alexandria’s transportation staff.

### **6.1. 2008 Existing Conditions**

As a first step, data compilation and network coding was performed to prepare the input data and the model network. In addition, model verification was conducted with the available data to replicate the

existing weekday morning, weekday evening, and Saturday peak conditions in the field. For this purpose, CORSIM model parameters such as mean startup delay and discharge headway were adjusted where necessary and input demand volumes were increased to represent the queue and the unserved demand. **Table 23** presents the Measures of Effectiveness (MOEs) for the signalized intersections for the existing weekday morning, weekday evening, and Saturday peak hour conditions within the study area from the CORSIM analysis.

**Table 23: Existing Conditions Signalized Intersection MOEs – CORSIM**

| Intersection Approach            | AM Peak Hour |                 |          | PM Peak Hour |                 |          | Saturday Peak Hour |                 |          |
|----------------------------------|--------------|-----------------|----------|--------------|-----------------|----------|--------------------|-----------------|----------|
|                                  | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)        | Delay (sec/veh) | LOS      |
| <b>King Street/Quaker Lane</b>   |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 1002         | 113.4           | F        | 997          | 58.6            | E        | 977                | 55.7            | E        |
| WB                               | 593          | 14.3            | B        | 877          | 6.0             | A        | 810                | 11.9            | B        |
| NB                               | 872          | 33.5            | C        | 718          | 7.3             | A        | 661                | 26.0            | C        |
| SB                               | 637          | 29.9            | C        | 1055         | 194.1           | F        | 690                | 27.9            | C        |
| <b>Overall</b>                   |              | <b>54.9</b>     | <b>D</b> |              | <b>75.0</b>     | <b>E</b> |                    | <b>32.0</b>     | <b>C</b> |
| <b>King Street/Braddock Road</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 836          | 20.4            | C        | 681          | 18.2            | B        | 383                | 12.0            | B        |
| WB                               | 670          | 23.4            | C        | 820          | 34.7            | C        | 559                | 19.4            | B        |
| SE                               | 618          | 31.2            | C        | 724          | 11.3            | B        | 608                | 17.1            | B        |
| NW                               | 301          | 41.7            | D        | 685          | 64.3            | E        | 494                | 33.0            | C        |
| <b>Overall</b>                   |              | <b>26.6</b>     | <b>C</b> |              | <b>32.0</b>     | <b>C</b> |                    | <b>20.6</b>     | <b>C</b> |
| <b>Braddock Road/Quaker Lane</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 989          | 43.1            | D        | 866          | 44.7            | D        | 525                | 31.3            | C        |
| WB                               | 383          | 33.4            | C        | 633          | 16.2            | B        | 264                | 42.4            | D        |
| NB                               | 961          | 166.9           | F        | 766          | 38.1            | D        | 745                | 28.5            | C        |
| SB                               | 605          | 15.3            | B        | 929          | 23.3            | C        | 664                | 14.6            | B        |
| <b>Overall</b>                   |              | <b>76.6</b>     | <b>E</b> |              | <b>31.2</b>     | <b>C</b> |                    | <b>26.6</b>     | <b>C</b> |

As shown in **Table 23**, the Braddock Road / Quaker Lane intersection is operating at capacity (LOS E) during the weekday morning peak hour. This is due to the heavy northbound volume, which is not fully serviced during the allocated signal green time. In addition, the King Street / Quaker Lane intersection is operating near capacity due to heavy eastbound volume during the weekday morning peak hour. During the weekday evening peak hour, the King Street / Quaker Lane intersection is operating at capacity (LOS E). During Saturday peak hour conditions, all the intersections are operating acceptably. The CORSIM results for these intersections are generally consistent with the results obtained from the

HCM analysis, although the magnitude of delay differs somewhat between the two analysis tools, as a result of differing analytical methodologies.

### 6.2. 2020 Baseline Conditions

The same CORSIM analysis parameters employed for the 2008 Existing Conditions analysis and the previously described future traffic volume projections were used to evaluate 2020 baseline conditions.

**Table 24** presents the MOE results from CORSIM for the signalized intersections for the 2020 baseline weekday morning, weekday evening, and Saturday peak hour conditions within the study area.

**Table 24: 2020 Baseline Conditions Signalized Intersection MOEs – CORSIM**

| Intersection Approach            | AM Peak Hour |                 |          | PM Peak Hour |                 |          | Saturday Peak Hour |                 |          |
|----------------------------------|--------------|-----------------|----------|--------------|-----------------|----------|--------------------|-----------------|----------|
|                                  | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)        | Delay (sec/veh) | LOS      |
| <b>King Street/Quaker Lane</b>   |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 997          | 136.1           | F        | 980          | 144.3           | F        | 952                | 147.6           | F        |
| WB                               | 688          | 18.9            | B        | 899          | 13.6            | B        | 913                | 11.0            | B        |
| NB                               | 912          | 32.4            | C        | 759          | 16.1            | B        | 782                | 29.2            | C        |
| SB                               | 714          | 29.2            | C        | 932          | 242.6           | F        | 855                | 28.6            | C        |
| <b>Overall</b>                   |              | <b>60.1</b>     | <b>E</b> |              | <b>109.8</b>    | <b>F</b> |                    | <b>56.5</b>     | <b>E</b> |
| <b>King Street/Braddock Road</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 901          | 19.7            | B        | 708          | 17.8            | B        | 419                | 15.1            | B        |
| WB                               | 726          | 23.6            | C        | 915          | 42.8            | D        | 696                | 22.1            | C        |
| SE                               | 623          | 32.5            | C        | 672          | 24.3            | C        | 624                | 17.0            | B        |
| NW                               | 365          | 38.3            | D        | 705          | 218.3           | F        | 569                | 37.2            | D        |
| <b>Overall</b>                   |              | <b>26.4</b>     | <b>C</b> |              | <b>74.0</b>     | <b>E</b> |                    | <b>23.2</b>     | <b>C</b> |
| <b>Braddock Road/Quaker Lane</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 1067         | 71.8            | E        | 894          | 169.1           | F        | 608                | 34.3            | C        |
| WB                               | 412          | 17.2            | B        | 728          | 38.7            | D        | 369                | 38.4            | D        |
| NB                               | 951          | 184.8           | F        | 821          | 195.5           | F        | 838                | 49.5            | D        |
| SB                               | 674          | 17.0            | B        | 852          | 21.1            | C        | 723                | 15.3            | B        |
| <b>Overall</b>                   |              | <b>87.3</b>     | <b>F</b> |              | <b>108.6</b>    | <b>F</b> |                    | <b>34.5</b>     | <b>C</b> |

As shown in **Table 24**, the CORSIM simulation suggests that the intersections of King Street / Quaker Lane and Braddock Road / Quaker Lane are anticipated to operate at or above capacity in the weekday morning peak hour, mainly due to heavy traffic volume demands on eastbound King Street, eastbound Braddock Road, and northbound Quaker Lane. During the weekday evening peak hour conditions, all of

the three study intersections are expected to operate at or above capacity. The King Street / Quaker Lane intersection would operate above capacity due to heavy volumes in the eastbound and southbound approaches. The Braddock Road / Quaker Lane intersection would operate above capacity due to heavy eastbound and northbound volume. During Saturday peak hour conditions, the King Street / Quaker Lane intersection is expected to operate at capacity (LOS E) due to heavy eastbound volume on King Street. The operations at these intersections for 2020 baseline conditions are also fairly consistent with the results obtained from HCM analysis although, again, the magnitude of delay differs somewhat between the two analysis methodologies.

### 6.3. 2020 Conceptual Alternative 1A

The same parameters assumed in the 2020 Baseline Conditions analysis were used to analyze Conceptual Alternative 1A using CORSIM micro-simulation analysis. Conceptual Alternative 1A includes the addition of left turn lanes in order to increase the capacity at the following critical movements:

- King Street / Quaker Lane intersection - addition of an eastbound left lane along King Street, from single to dual left turn lane configuration.
- King Street / Braddock Road intersection - addition of a south-eastbound left lane along King Street, from single to dual left turn lane configuration.
- Braddock Road / Quaker Lane intersection- addition of a westbound left lane along Braddock Road, from single to dual left turn lane configuration.

**Table 25** presents the MOEs from CORSIM for the signalized intersections for Conceptual Alternative 1A during three weekday morning, weekday evening, and Saturday peak hour conditions within the study area. As shown in the table, under future 2020 conditions, the intersection of Braddock Road / Quaker Lane is anticipated to operate above capacity during the weekday morning peak hour, mainly due to heavy northbound approach volume. However, compared to the 2020 Baseline Conditions, overall delay and delay on the eastbound and south-eastbound approaches would be reduced with the addition of left-turn lanes on King Street, providing dual left-turn lane configurations.

Table 25: 2020 Conditions - Alternative 1A Signalized Intersection CORSIM MOEs

| Intersection Approach            | AM Peak Hour |                 |          | PM Peak Hour |                 |          | Saturday Peak Hour |                 |          |
|----------------------------------|--------------|-----------------|----------|--------------|-----------------|----------|--------------------|-----------------|----------|
|                                  | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)        | Delay (sec/veh) | LOS      |
| <b>King Street/Quaker Lane</b>   |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 1120         | 72.0            | E        | 1016         | 127.1           | F        | 1041               | 123.1           | F        |
| WB                               | 688          | 11.9            | B        | 940          | 5.3             | A        | 921                | 8.6             | A        |
| NB                               | 946          | 21.2            | C        | 805          | 8.8             | A        | 801                | 19.1            | B        |
| SB                               | 712          | 28.1            | C        | 977          | 225.7           | F        | 855                | 26.1            | C        |
| <b>Overall</b>                   |              | <b>37.2</b>     | <b>D</b> |              | <b>96.8</b>     | <b>F</b> |                    | <b>48.0</b>     | <b>D</b> |
| <b>King Street/Braddock Road</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 913          | 18.4            | B        | 746          | 20.6            | C        | 420                | 13.8            | B        |
| WB                               | 750          | 23.3            | C        | 915          | 32.9            | C        | 699                | 23.0            | C        |
| SE                               | 678          | 24.4            | C        | 719          | 9.6             | A        | 676                | 13.4            | B        |
| NW                               | 362          | 41.1            | D        | 751          | 97.0            | F        | 575                | 36.4            | D        |
| <b>Overall</b>                   |              | <b>24.3</b>     | <b>C</b> |              | <b>40.0</b>     | <b>D</b> |                    | <b>21.9</b>     | <b>C</b> |
| <b>Braddock Road/Quaker Lane</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 1097         | 58.6            | E        | 939          | 49.3            | D        | 604                | 31.8            | C        |
| WB                               | 429          | 20.8            | C        | 729          | 10.9            | B        | 369                | 29.2            | C        |
| NB                               | 1019         | 169.1           | F        | 867          | 123.1           | F        | 855                | 37.1            | D        |
| SB                               | 679          | 19.0            | B        | 891          | 21.0            | C        | 751                | 15.0            | B        |
| <b>Overall</b>                   |              | <b>80.2</b>     | <b>F</b> |              | <b>52.4</b>     | <b>D</b> |                    | <b>28.3</b>     | <b>C</b> |

During the weekday evening peak hour conditions, King Street / Quaker Lane is expected to continue operating above capacity due to heavy eastbound and southbound approach volume. However, significant improvement is anticipated to occur at the Braddock Road / Quaker Lane intersection, which would operate at an acceptable LOS D, with a significant decrease in delay along the eastbound approach, after completion of the Alternative 1A modifications. This improvement is the result of reconfiguration of the westbound approach and reallocation of the signal green time for the eastbound approach.

During Saturday peak hour conditions, all three of the key study intersections would operate at LOS D or better with a slight decrease in delay due to the addition of left-turn lanes at all three locations. Therefore, the micro-simulation analysis for Conceptual Alternative 1A confirms the capacity analysis finding that this alternative is anticipated to improve the overall operational performance of the key study intersections, when compared to 2020 Baseline Conditions.

6.4. 2020 Conceptual Alternative 1Ai

The same parameters assumed in the 2020 baseline conditions analysis were used to analyze the Conceptual Alternative 1Ai using the CORSIM micro-simulation analysis. Conceptual Alternative 1Ai includes the addition of a second northbound left turn lane along Quaker Lane at King Street, which would reconfigure the approach from a single to a dual left-turn lane configuration. **Table 26** presents the MOE results from CORSIM for the signalized intersections for Conceptual Alternative 1Ai during the weekday morning, weekday evening, and Saturday peak hour conditions within the study area.

**Table 26: 2020 Conditions - Alternative 1Ai Signalized Intersection CORSIM MOEs**

| Intersection Approach            | AM Peak Hour |                 |          | PM Peak Hour |                 |          | Saturday Peak Hour |                 |          |
|----------------------------------|--------------|-----------------|----------|--------------|-----------------|----------|--------------------|-----------------|----------|
|                                  | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)        | Delay (sec/veh) | LOS      |
| <b>King Street/Quaker Lane</b>   |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 1130         | 49.3            | D        | 1031         | 108.4           | F        | 1048               | 121.9           | F        |
| WB                               | 701          | 11.2            | B        | 935          | 10.4            | B        | 914                | 8.7             | A        |
| NB                               | 1001         | 11.0            | B        | 804          | 15.2            | B        | 802                | 36.1            | D        |
| SB                               | 717          | 26.5            | C        | 1020         | 216.4           | F        | 859                | 26.1            | C        |
| <b>Overall</b>                   |              | <b>26.4</b>     | <b>C</b> |              | <b>93.5</b>     | <b>F</b> |                    | <b>51.6</b>     | <b>D</b> |
| <b>King Street/Braddock Road</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 931          | 20.4            | C        | 739          | 21.5            | C        | 416                | 8.4             | A        |
| WB                               | 742          | 23.1            | C        | 915          | 30.9            | C        | 704                | 24.4            | C        |
| SE                               | 700          | 29.7            | C        | 712          | 14.6            | B        | 674                | 11.1            | B        |
| NW                               | 369          | 40.5            | D        | 740          | 77.9            | E        | 575                | 35.6            | D        |
| <b>Overall</b>                   |              | <b>26.2</b>     | <b>C</b> |              | <b>36.1</b>     | <b>D</b> |                    | <b>20.5</b>     | <b>C</b> |
| <b>Braddock Road/Quaker Lane</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 1107         | 43.0            | D        | 910          | 51.0            | D        | 607                | 33.5            | C        |
| WB                               | 429          | 17.4            | B        | 714          | 9.5             | A        | 374                | 46.9            | D        |
| NB                               | 1090         | 156.5           | F        | 879          | 119.1           | F        | 843                | 43.0            | D        |
| SB                               | 679          | 16.6            | B        | 937          | 18.1            | B        | 753                | 9.9             | A        |
| <b>Overall</b>                   |              | <b>71.7</b>     | <b>E</b> |              | <b>50.8</b>     | <b>D</b> |                    | <b>31.7</b>     | <b>C</b> |

As shown in **Table 26**, the intersection of Braddock Road / Quaker Lane is expected to operate at capacity in the weekday morning peak hour, mainly due to heavy northbound approach volume. However, compared to that of Conceptual Alternative 1A, delay for the King Street / Quaker Lane and Braddock Road / Quaker Lane intersections is expected to be reduced. The reduction in delay is due to the addition of a second northbound left turn lane along Quaker Lane. A slight increase in overall delay is anticipated at the intersection of King Street / Braddock Road due to heavier volume, mainly in the

eastbound and south-eastbound directions. When compared to the 2020 Baseline Conditions, delay for all three intersections is expected to decrease and intersection operations are expected to improve at all locations.

During the weekday evening peak hour conditions, the King Street / Quaker Lane intersection is expected to continue operating above capacity due to heavy eastbound and southbound approach volume. However, intersection delay is anticipated to decrease slightly compared to Conceptual Alternative 1A, due to the addition of a second northbound left-turn lane. Additionally, overall delay at the intersections of King Street / Braddock Road and Braddock Road / Quaker Lane would decrease slightly compared to Conceptual Alternative 1A and both intersections would continue to operate at acceptable LOS D. The reduction in delay at these intersections is mainly due to improved flows at the King Street / Quaker Lane intersection, which reduces the occurrence of spillback and delays at the adjacent intersections.

During Saturday peak hour conditions, all three study intersections are expected to operate at LOS D with minimal changes in delay at the three locations. Therefore, similar to the capacity analysis findings for this alternative, the micro-simulation results suggest that Conceptual Alternative 1Ai is anticipated to improve the overall operational performance when compared to Conceptual Alternative 1A and 2020 Baseline Conditions, most notably during weekday morning peak hour conditions.

### **6.5. 2020 Conceptual Alternative 2A**

The same parameters assumed in the 2020 Baseline Conditions were used to analyze the Conceptual Alternative 2A using CORSIM micro-simulation analysis. Conceptual Alternative 2A reduces the number of conflict points by removing the Braddock Road segment between Quaker Lane and King Street and includes the addition of a left-turn lane at the following approaches, in order to increase the capacity at these critical movements:

- King Street / Quaker Lane intersection - addition of an eastbound and westbound left-turn lane along King Street, upgrading this movement from a single to a dual left-turn lane configuration.
- King Street / Braddock Road intersection - addition of a south-eastbound left-turn lane along King Street, upgrading this movement from a single to a dual left-turn lane configuration.

Table 27 presents the MOEs from CORSIM for the signalized intersections for Conceptual Alternative 2A during the weekday morning, weekday evening, and Saturday peak hour conditions within the study area.

**Table 27: 2020 Conditions - Alternative 2A Signalized Intersection CORSIM MOEs**

| Intersection Approach            | AM Peak Hour |                 |          | PM Peak Hour |                 |          | Saturday Peak Hour |                 |          |
|----------------------------------|--------------|-----------------|----------|--------------|-----------------|----------|--------------------|-----------------|----------|
|                                  | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)        | Delay (sec/veh) | LOS      |
| <b>King Street/Quaker Lane</b>   |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 741          | 238.4           | F        | 934          | 157.6           | F        | 1144               | 120.7           | F        |
| WB                               | 1057         | 62.7            | E        | 891          | 122.0           | F        | 1157               | 76.0            | E        |
| NB                               | 1550         | 25.4            | C        | 1437         | 24.8            | C        | 1133               | 36.0            | D        |
| SB                               | 714          | 46.2            | D        | 925          | 257.9           | F        | 845                | 43.4            | D        |
| <b>Overall</b>                   |              | <b>77.6</b>     | <b>E</b> |              | <b>126.6</b>    | <b>F</b> |                    | <b>70.9</b>     | <b>E</b> |
| <b>King Street/Braddock Road</b> |              |                 |          |              |                 |          |                    |                 |          |
| WB                               | 731          | 47.9            | D        | 567          | 379.4           | F        | 653                | 248.5           | F        |
| SE                               | 1194         | 14.4            | B        | 1372         | 15.2            | B        | 1134               | 20.4            | C        |
| NW                               | 355          | 25.7            | C        | 319          | 618.5           | F        | 513                | 56.9            | E        |
| <b>Overall</b>                   |              | <b>26.9</b>     | <b>C</b> |              | <b>191.9</b>    | <b>F</b> |                    | <b>93.3</b>     | <b>F</b> |
| <b>Braddock Road/Quaker Lane</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 890          | 176.2           | F        | 807          | 187.4           | F        | 588                | 113.9           | F        |
| NB                               | 879          | 210.4           | F        | 885          | 82.5            | F        | 773                | 218.3           | F        |
| SB                               | 1119         | 12.6            | B        | 1168         | 13.3            | B        | 1128               | 9.7             | A        |
| <b>Overall</b>                   |              | <b>123.2</b>    | <b>F</b> |              | <b>83.8</b>     | <b>F</b> |                    | <b>99.1</b>     | <b>F</b> |

As shown in Table 27, the intersection of King Street /Quaker Lane is expected to operate at capacity during the weekday morning peak hour because the eastbound approach volume would not be fully serviced during the allocated green time. This is due to the significant increase in westbound and northbound volumes caused by the diversion of traffic from the removal of the Braddock Road segment between Quaker Lane and King Street. In addition, the Braddock Road / Quaker Lane intersection is anticipated to continue operating over capacity during the weekday morning peak hour, due to signal coordination challenges between the intersections of King Street / Quaker Lane and Braddock Road / Quaker Lane.

During the weekday evening peak hour conditions, all three study intersections are expected to continue operating over capacity with no significant improvements anticipated due to the Alternative 2A

reconfiguration of the study intersections. In fact, operations at the Braddock Road / King Street intersection are expected to deteriorate due to the increase in delay that would be anticipated along the westbound approach of Braddock Road and the north-westbound King Street approach. This increase in delay is caused by spillback and congestion, particularly on the westbound King Street approach to Quaker Lane, which is expected to interfere with the through movements at the Braddock Road / Quaker Lane intersection.

During the Saturday peak hour conditions, the King Street / Quaker Lane intersection is anticipated to operate at capacity, primarily as a result of significant increases in traffic volume on the westbound and northbound approaches. Additionally, operations at the King Street / Braddock Road and Braddock Road / Quaker Lane intersections are expected to deteriorate, compared to 2020 Baseline Conditions. At the King Street / Braddock Road intersection, increasing traffic volumes on the eastbound and southbound approaches will not be fully serviced during the allocated green time. At the Braddock Road / Quaker Lane intersection, increasing traffic volume is expected to increase in delay on the westbound approach of Braddock Road and the north-westbound approach along King Street.

Therefore, the micro-simulation results for Conceptual Alternative 2A do not corroborate the results of the capacity analysis discussed in the previous chapter. This micro-simulation of Conceptual Alternative 2A indicates that this alternative is not anticipated to improve the overall operational performance of the critical study intersections when compared to 2020 Baseline Conditions.

### **6.6. 2020 Conceptual Alternative 2Ai**

The same parameters assumed in the 2020 Baseline Conditions analysis were used to analyze the Conceptual Alternative 2Ai, using CORSIM micro-simulation analysis. In addition to the improvements associated with Conceptual Alternative 2A, Conceptual Alternative 2Ai proposes a second northbound left-turn lane along Quaker Lane at King Street, which would reconfigure the approach from a single to a dual left-turn lane configuration. **Table 28** presents the MOE results from CORSIM for the signalized intersections under the 2020 Conceptual Alternative 2Ai weekday morning, weekday evening, and Saturday peak hour conditions.

**Table 28: 2020 Conditions - Alternative 2Ai Signalized Intersection CORSIM MOEs**

| Intersection Approach            | AM Peak Hour |                 |          | PM Peak Hour |                 |          | Saturday Peak Hour |                 |          |
|----------------------------------|--------------|-----------------|----------|--------------|-----------------|----------|--------------------|-----------------|----------|
|                                  | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)  | Delay (sec/veh) | LOS      | Trips (veh)        | Delay (sec/veh) | LOS      |
| <b>King Street/Quaker Lane</b>   |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 797          | 225.2           | F        | 899          | 165.2           | F        | 1115               | 125.7           | F        |
| WB                               | 1049         | 53.8            | D        | 921          | 114.3           | F        | 1172               | 75.5            | E        |
| NB                               | 1568         | 25.6            | C        | 1491         | 23.6            | C        | 1195               | 32.6            | C        |
| SB                               | 714          | 47.6            | D        | 930          | 258.6           | F        | 846                | 45.0            | D        |
| <b>Overall</b>                   |              | <b>75.1</b>     | <b>E</b> |              | <b>124.8</b>    | <b>F</b> |                    | <b>70.6</b>     | <b>E</b> |
| <b>King Street/Braddock Road</b> |              |                 |          |              |                 |          |                    |                 |          |
| WB                               | 721          | 46.2            | D        | 534          | 406.9           | F        | 680                | 204.8           | F        |
| SE                               | 1231         | 16.2            | B        | 1376         | 15.7            | B        | 1147               | 19.3            | B        |
| NW                               | 359          | 13.8            | B        | 385          | 527.2           | F        | 508                | 95.0            | F        |
| <b>Overall</b>                   |              | <b>25.2</b>     | <b>C</b> |              | <b>192.5</b>    | <b>F</b> |                    | <b>89.8</b>     | <b>F</b> |
| <b>Braddock Road/Quaker Lane</b> |              |                 |          |              |                 |          |                    |                 |          |
| EB                               | 868          | 187.4           | F        | 852          | 163.6           | F        | 596                | 107.4           | F        |
| NB                               | 932          | 194.2           | F        | 893          | 55.6            | E        | 836                | 180.5           | F        |
| SB                               | 1130         | 11.3            | B        | 1191         | 12.7            | B        | 1134               | 9.8             | A        |
| <b>Overall</b>                   |              | <b>121.6</b>    | <b>F</b> |              | <b>69.5</b>     | <b>E</b> |                    | <b>88.1</b>     | <b>F</b> |

As shown in **Table 28**, during the weekday morning peak hour conditions, all three study intersections would continue to operate a similar LOS as Conceptual Alternative 2A, but the overall intersection delay at most locations is expected to decrease slightly due to the addition of a northbound left-turn lane along Quaker Lane at King Street, upgrading this location from a single to a dual left- turn lane configuration. However, compared to 2020 Baseline Conditions, the intersections of King Street /Quaker Lane and Braddock Road / Quaker Lane would continue to operate at or above capacity.

During the weekday evening peak hour conditions, the King Street / Quaker Lane and King Street / Braddock Road intersections would continue to operate above capacity, with slight delay improvements anticipated, compared to Conceptual Alternative 2A. The most noticeable improvement would occur at the Braddock Road / Quaker Lane intersection, which shows improved delay due to additional capacity provided at the intersection of King Street / Quaker Lane located downstream. However, all of the study intersections are expected to continue operating over capacity.

During the Saturday peak hour conditions when compared to Conceptual Alternative 2A, the King Street / Quaker Lane and King Street / Braddock Road intersections would continue to operate at or over capacity with slight improvements anticipated, due to the additional northbound left-turn lane on Quaker Lane. Although the intersection would continue to operate above capacity, the most noticeable improvement would occur at the Braddock Road / Quaker Lane intersection, which shows a reduction in overall intersection delay. However, none of the study intersections show improvement compared to 2020 Baseline Conditions.

Therefore, although Conceptual Alternative 2Ai would improve the overall operational performance at the study intersections when compared to Conceptual Alternative 2A, this concept is still not anticipated to improve the overall operational performance of the critical study intersections when compared to 2020 Baseline Conditions. This is mainly due to significant volume increases, and the resulting queue spillback on certain approaches, caused by traffic diversions associated with the removal of a segment of Braddock Road. The micro-simulation results indicate that Conceptual Alternative 2Ai is unlikely to achieve the operational benefits originally attributed to this alternative by the capacity analysis, provided in the previous chapter.

The following is a summary of the approaches most significantly affected by the Alternative 2A and 2Ai concepts:

- Traffic operations deteriorate significantly on the eastbound and northbound approaches at the Braddock Road / Quaker Lane intersection and northbound approach at the King Street / Quaker Lane intersection during weekday morning peak hour conditions.
- Traffic operations deteriorate significantly on the westbound and north-westbound approaches at the Braddock Road / King Street intersection and westbound approach at the King Street / Quaker Lane intersection during weekday evening peak hour conditions.
- Traffic operations for various approaches within the intersections deteriorate during the Saturday peak hour, but generally less significantly than the weekday peak hours.

### **6.7. Micro-simulation Analysis Summary**

VHB has conducted a CORSIM micro-simulation analyses for two major improvement alternatives for the Braddock Road / King Street/ Quaker Lane intersections. These two alternatives were selected for

micro-simulation evaluation based on the results of the capacity analyses (provided in the previous chapter), public comments, and consultation with the City of Alexandria's transportation staff. The following is a description of the two potential design alternatives:

- Alternatives 1A/B and 1Ai: construction of dual left-turn lanes at multiple locations.
- Alternatives 2A and 2Ai: Remove Braddock Road segment between Quaker Lane and King Street and construct dual left-turn lanes on multiple critical movements within the intersections.

The CORSIM analysis confirms the previous capacity analysis results for Alternatives 1A/B and 1Ai. The simulation results indicate that both of these alternatives are expected to provide significant operational benefits to the study intersections, improving overall capacity and reducing vehicular delay for vehicles traveling in the study area.

Regarding Alternatives 2A and 2Ai, the CORSIM analysis contradicts the previous capacity analysis results and indicates that these alternatives are unlikely to provide operational benefits. In fact, either of these alternatives may result in both increased delay and deteriorating levels-of-service at all three study intersections.

## **7. Service Road and Transit Improvements**

Improvements to the transit system within the study area should be made in conjunction with, and in consideration of, the potential roadway improvement concepts previously described in this study. Coordination between roadway and transit improvements is essential because changes made to the roadway may impact the existing location of bus stops or impact bus routes.

Among the areas of greatest concern are the bus circulation and stops located near the intersection of King Street / Taylor Street and the service road that runs parallel with King Street, to the west of Quaker Street. Specific concerns include:

- Vehicle interaction between the closely-spaced King Street / Taylor Street and service road / Bradlee Shopping Center access intersections is confusing (drivers often appear unsure as to which vehicular movement has the right of way).

- The service road experiences high through traffic volumes, which conflicts with traffic from King Street or Taylor Street accessing the service road or the Bradlee Shopping Center.
- Potential conflicts exist between vehicles on the service road and pedestrian transit users, as they cross the roadway to reach the bus stop located on the far side of the roadway from the shopping center.

Improvements that will improve the interaction of bus traffic with vehicular traffic accessing and exiting the shopping center should be considered. One potential concept is illustrated in **Figure 20**. The improvements depicted in **Figure 20** include closing sections of the service road, in order to eliminate end-to-end through trips traveling along the service road.

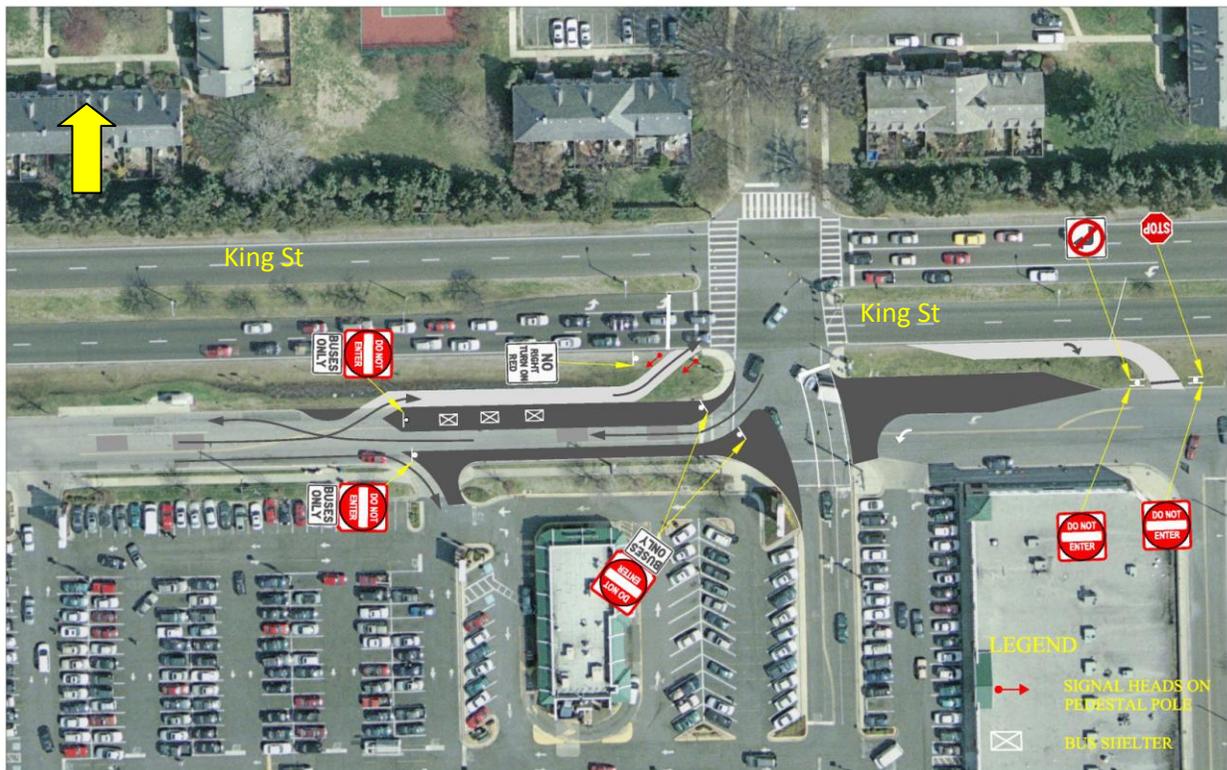


Figure 20: Service Road and Bus Stop Improvement

For this purpose, an approximately 300-foot section of service road, on both sides of Taylor Street, would be closed to vehicular traffic and would be converted to a transit center. All traffic on the service road from the west would be forced to turn into one of the two shopping center driveways west of Taylor Street, while all traffic from the east would be forced into the shopping center to the east of

Taylor Street. By restricting access, all existing through traffic using the service road would be shifted back onto King Street. This concept entirely eliminates the intersection of the existing service road and the Bradlee Shopping Center access, while retaining service road access to the shopping center at other locations.

This concept also includes a proposed turn/slip lane from King Street to the service road, located to the east of the King Street / Taylor Street intersection. This lane would permit traffic on King Street to reach Marlee Way and to efficiently access properties along the service road to the east of Taylor Street. Access to the transit center will be provided via a slip lane, constructed to provide eastbound buses access to King Street at the Taylor Street intersection. This section of the transit center roadway would be restricted to buses only, and would be signed as such. Buses would stop at the transit center to pick-up or drop-off riders. This activity would take place on a central platform, which would be located within the existing service road footprint, in front of the McDonalds. Additionally, the traffic signal phasing would be modified to provide the buses with a queue jump signal phase, to allow the buses to exit the transit center prior to normal traffic flow commencing on King Street. Detection equipment on the bus lane would activate the queue jump phase only if a bus is present.

The benefit of implementing this alternative is that it would provide a central platform for existing transit users as they wait during transfers. It would provide the benefit of not having to cross the roadway between transfers.

Using the service road and bus stop improvement concept as described above, sensitivity testing was performed using Synchro analysis tools to determine the impact the transit center's operations (i.e. the number of buses and pedestrian calls) would have on the operation of the intersection at King Street / Taylor Street. **Table 29** summarizes the results for the various scenarios that were examined.

**Table 29: 2020 Conditions - Sensitivity Testing of Service Road and Bus Stop Improvement**

| Scenario | Buses | Pedestrian Calls | AM Peak Hour |     |                 | PM Peak Hour |     |                 | Saturday Peak Hour |     |                 |
|----------|-------|------------------|--------------|-----|-----------------|--------------|-----|-----------------|--------------------|-----|-----------------|
|          |       |                  | V/C          | LOS | Delay (sec/veh) | V/C          | LOS | Delay (sec/veh) | V/C                | LOS | Delay (sec/veh) |
| S1       | 0     | 0                | 0.55         | B   | 17.4            | 0.62         | C   | 20.2            | 0.86               | F   | 97.3            |
| S2       | 6     | 10               | 0.63         | C   | 24.3            | 0.71         | C   | 29.5            | 0.98               | F   | 185.1           |
| S3       | 12    | 25               | 0.70         | C   | 31.9            | 0.80         | D   | 52.8            | 1.1                | F   | 204.1           |
| S4       | 18    | 50               | 0.76         | D   | 36.5            | 0.86         | F   | 85.3            | 1.18               | F   | 200.5           |

As shown in **Table 29**, as the number of buses and pedestrian calls increase the total effective green time for the eastbound and westbound through traffic movements would decrease, because additional time is required to service the bus and pedestrian volumes. This data indicates that operations at this intersection would deteriorate as both buses and pedestrian calls increase.

During the weekday morning peak hour conditions, the intersection would operate at LOS D or better even with a maximum loading of 18 buses and 50 pedestrian calls. Operation of the transit center would have greater affects on the weekday evening and Saturday peak hour periods, when the heaviest traffic activity at the shopping center takes place. This sensitivity test indicates that during the weekday evening peak hour conditions, the intersection would operate above capacity only when approximately 18 buses and 50 pedestrian calls are served. Due to heavier traffic volumes during the Saturday peak hour conditions, the intersection is expected to operate over capacity regardless of the number of bus or pedestrian calls during this time period.

This analysis illustrates that as the number of buses and pedestrian calls increase, the level of service for the intersection will degrade. However, provision of a dedicated transit center at this location could provide other benefits to the transportation network and community, including:

- potential increases in transit ridership, which may reduce the total vehicular trips and single-occupant vehicles traveling in the area;
- elimination of cut-through traffic using the service road instead of King Street; and
- reduction of conflict points at the King Street / Taylor Street / Bradlee shopping center access, which may improve operations and safety at this intersection.

The primary disadvantage of this alternative is a potential increase in overall delay at key intersections such as Quaker Lane and King Street, which is expected by virtue of diverting through vehicles away from the service road, thereby increasing through volumes on King Street.

## 8. Other Improvements

### 8.1. Short Term Improvements

Short term and relatively minor improvements that can be implemented to improve safety without significant effort are identified in **Figure 21** for the intersections of King Street, Braddock Road, and Quaker Lane. These improvements include trimming trees to improve lines of sight, especially along King Street and Quaker Lane, as well as providing traffic control and guide signs at various locations.

**Figure 22** presents the short term improvements with the option of closing the service road at the intersections of King Street, Braddock Road, and Quaker Lane. In terms of trimming trees, the City would limit trimming of trees specifically within the footprint of the roadway to minimize impact to the vegetation. The horizontal sight distance should not be impeded due to tree overhang.

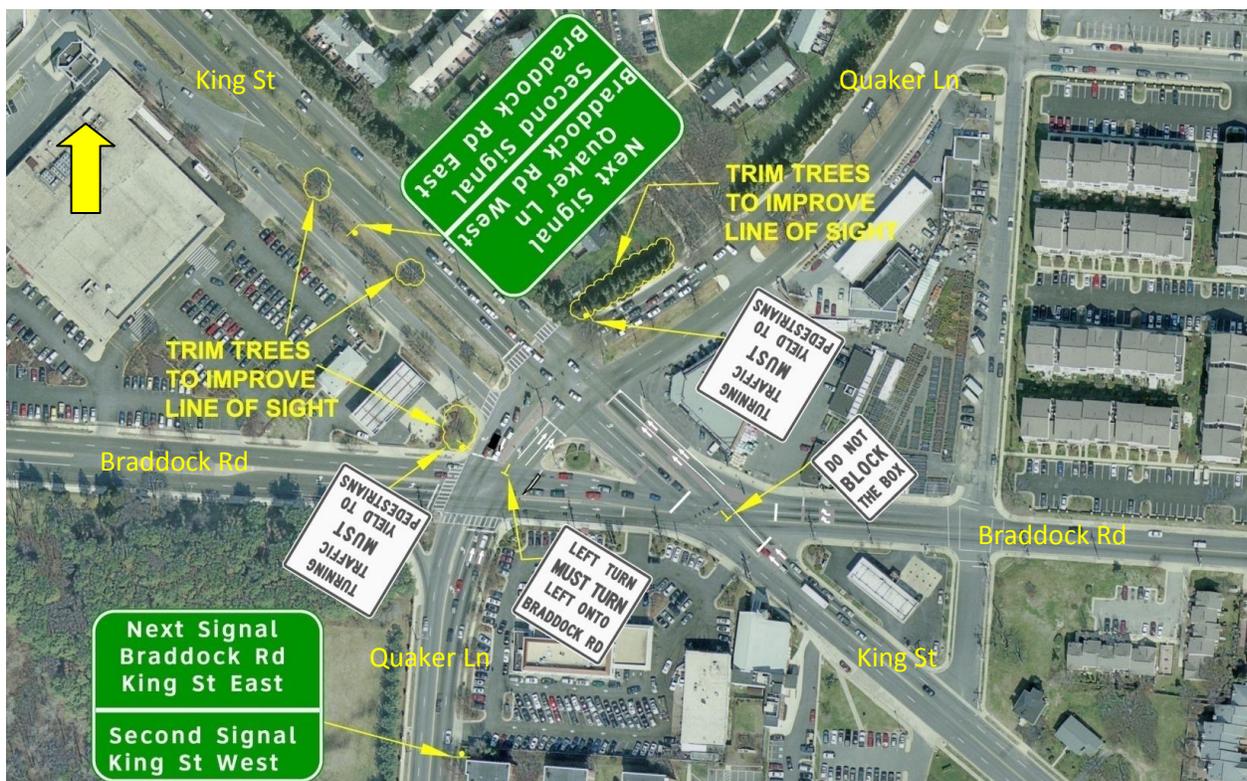


Figure 21: Short Term Improvements at Braddock/King/Quaker Intersections

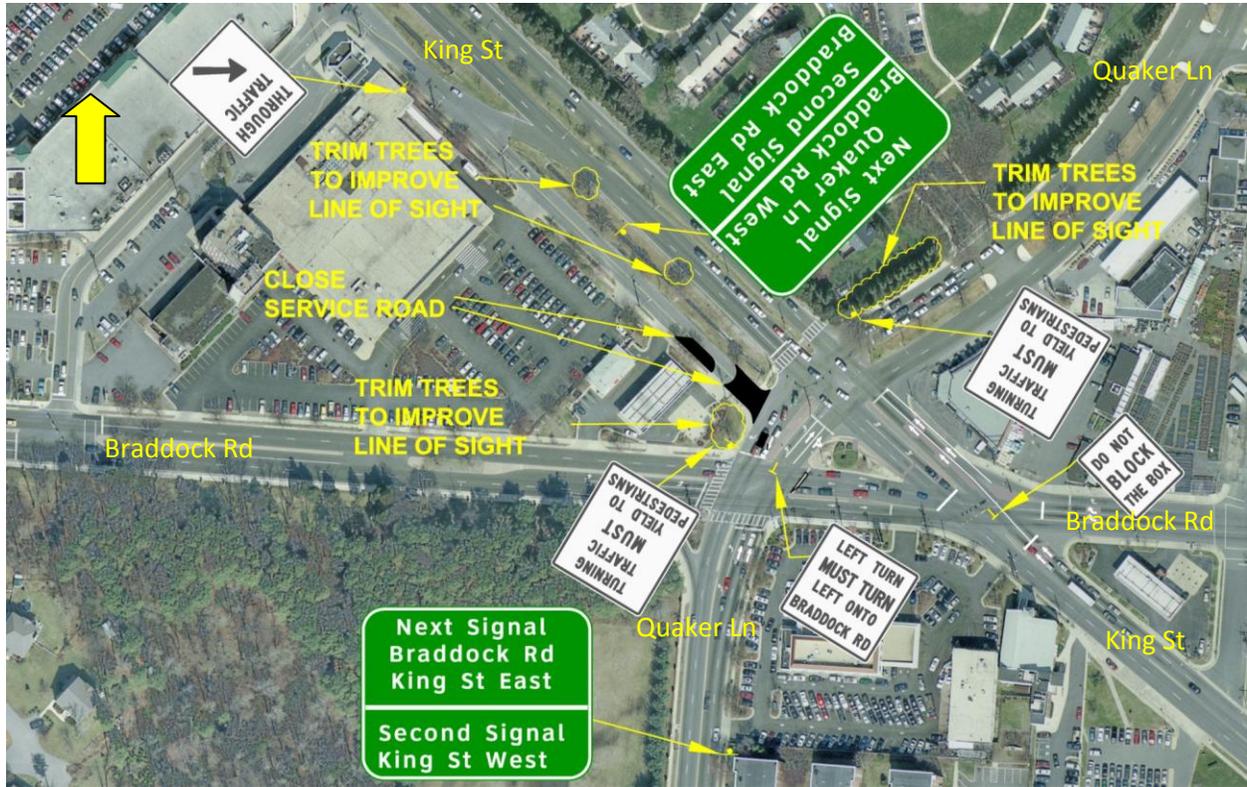


Figure 22: Short Term Improvements with Option to Close Service Road

**Potential Short-term Improvements at King Street / Dearing Street - Wakefield Street**

Further short-term, relatively minor improvements that can be implemented were identified at the intersections of King Street at Dearing Street / Wakefield Street as shown in **Figure 23** Error! Reference source not found.. Improvements to the service road include relocation of signage and restriping the roadway. The improvements include relocating signs for the westbound service road approach, as this would encourage vehicles to stop further back.



Figure 23: Short Term Improvements at King Street/Dearing Street

For the westbound direction on the service road, the stop bar is behind the crosswalk and the in-pavement loop detectors are located properly at the stop bars. Consequently, the loop located behind the stop bar is further back from the intersection and is not in the proximity of the stop sign. If a single car was stopped at this location, there is a high probability that the vehicle would not be detected and the signal controller would not provide the phase for the service road. Therefore, it is recommended that the signs to be relocated from the current location of near the crosswalk to the stop bar. This measure is likely to increase the incidence of drivers properly stopping at the relocated stop sign, which will place the vehicle on the loop detector; improve the sight line for the through movement by keeping the right-turning vehicles out of the line of sight; and allow vehicles in the left-turn lane to see the intersection better. For the eastbound approach, restriping of the roadway to narrow the lane would function as a traffic calming measure and would widen the departure leg so that the turning buses do not encroach on the approach where buses currently overhang. Full descriptions of the detailed findings are included in the Appendix.

An additional improvement that could be implemented would be to fully signalize the intersection between Dearing Street and the Service Road. Completion of a traffic signal study, including a signal warrant analysis, would be necessary prior to signalizing the intersection. The adjacent King Street / Dearing Street / Wakefield Street signal would also need to be incorporated into the study, as the two signals would share a controller or work in coordination. Elements that would have to be considered would include, but are not limited to:

- Coordination of two closely spaced intersections and possible impacts to traffic flow; and
- Impacts of reduced green time for King Street traffic, at the King Street / Dearing Street / Wakefield Street signal, as the Dearing Street approach would require a longer green phase. The longer green phase would be needed to facilitate safe movements of traffic at the Dearing Street and Service Road approaches as they travel into the signal at King Street / Dearing Street.

### **General Transit Improvements**

To improve transit ridership, bus shelters could be provided at existing bus stops that do not have shelters. Currently, a limited number of bus stops have shelters, there are at two (2) of the eight (8) stops at the intersection of Quaker Lane / Seminary Road / Janneys Lane, two (2) along the service road at the Bradlee Shopping Center, one along the service road west of Dearing Street, and one along King Street vicinity to TC Williams high school. Bus stops along with the stops with the shelters are shown in

**Figure 5.** Providing shelters could encourage an increase in ridership, as they would offer protection from the elements during periods of inclement weather. There are no existing bus pullout areas at any of the bus stops within the study area. Bus pullout areas could be provided at locations of heavier traffic flow, so that buses do not impede traffic flow while riders board and alight from the buses. However, with pullouts, it is difficult for buses to merge into traffic after stopping and far side pullout areas are known to be better than near side pullout.

In addition to the short term improvement options identified above, VHB further conducted a detail field review looking for some additional low cost activities that could be implemented through basic maintenance operations at the three intersections of King Street / Braddock Road/ Quaker Lane. These potential improvements are summarized according to each location as follows:

**Potential Short-term Improvements at King Street / Quaker Lane Intersection**

Potential short-term improvements are listed based on field observations and accident trends at the intersection of King Street and Quaker Lane.

- Generally, signal visibility is adequate. However, in order to reduce angle crashes for Quaker Road northbound approach and King Street westbound approach, Select View Signal Heads could be used for the Quaker Lane northbound approach along with timing adjustments that would shut down signal heads for Quaker Road northbound approach at the intersection with Braddock Road first, providing traffic to clear this intersection. An additional all red clearance interval time could also be considered in order to decrease the likelihood of crashes occurring due to northbound red light violations.
- As shown in **Figure 21**, closure of the service road at the intersection of King Street, Braddock Road, and Quaker Lane may improve the flow for the eastbound approach at this intersection.

**Potential Short-term Improvements at Braddock Road / Quaker Lane Intersection**

Potential short-term improvement measures are described based on field observations and accident trends at the intersection of Braddock Road and Quaker Lane.

- Potential Improvement Measure 1



**Issues:** Utility pole placed in the sidewalk on the southwest quadrant along the south side of Braddock Road and the attached power company box to this pole is obstructing pedestrian mobility. In addition, the pedestrian crossing sign is attached too high to this utility pole for the Braddock Road eastbound approaching vehicles to recognize.

**Proposed Improvement:** The power company box should be shifted or relocated to minimize impact and the pedestrian crossing sign should be lowered.

- Potential Improvement Measure 2



**Issues:** There is a possibility that drivers along Braddock Road eastbound at Quaker Lane could confuse the signal heads placed at King Street due to the close proximity of the two intersections along Braddock Road.

**Proposed Improvement:** Programmable Select View Signal Heads could be used for the signal heads controlling the Braddock Road eastbound approach along with timing adjustments.

- Potential Improvement Measure 3



**Issues:** The western- most pedestrian ramp on the south side of the Braddock Road eastbound approach, leading to the channelizing island is obstructed from sight due to the brick wall and utility pole.

**Proposed Improvement:** Shifting the crosswalk ramps further north can be one option in terms of improving the line of sight for pedestrians and the eastbound right turning vehicles.

- Potential Improvement Measure 4



**Issues:** There are frequent occurrences where pedestrians are crossing the roadway at locations where crosswalks are undesignated in order to get to their destination via the shortest path and avoid crossing multiple crosswalks.

**Proposed Improvement:** Placement of additional crosswalks needs to be considered accounting for the shortest path and the safety aspects of pedestrian activity.

- Potential Improvement Measure 5



**Issues:** Due to the horizontal alignment along Quaker Lane and the overgrown trees placed on the right side of the roadway, it is difficult to detect in advance the signal heads for the northbound approach along Quaker Lane.

**Proposed Improvement:** Providing an additional signal head on the left side towards the center of the Quaker Lane and trimming the trees would help enhance the signal conspicuity in advance for the northbound drivers approaching the intersection.

- Potential Improvement Measure 6



**Issues:** Plastic poles with reflector tapes attached are placed at the median islands to warn drivers about the median islands and to advise drivers to keep to right of the roadway. However, along the west leg of the intersection, the pole is missing.

**Proposed Improvement:** Installing the poles along with the “Keep Right (R4-7)” signs at all medians would be advisable in order to improve safe vehicular maneuvers in the vicinity of the median islands.

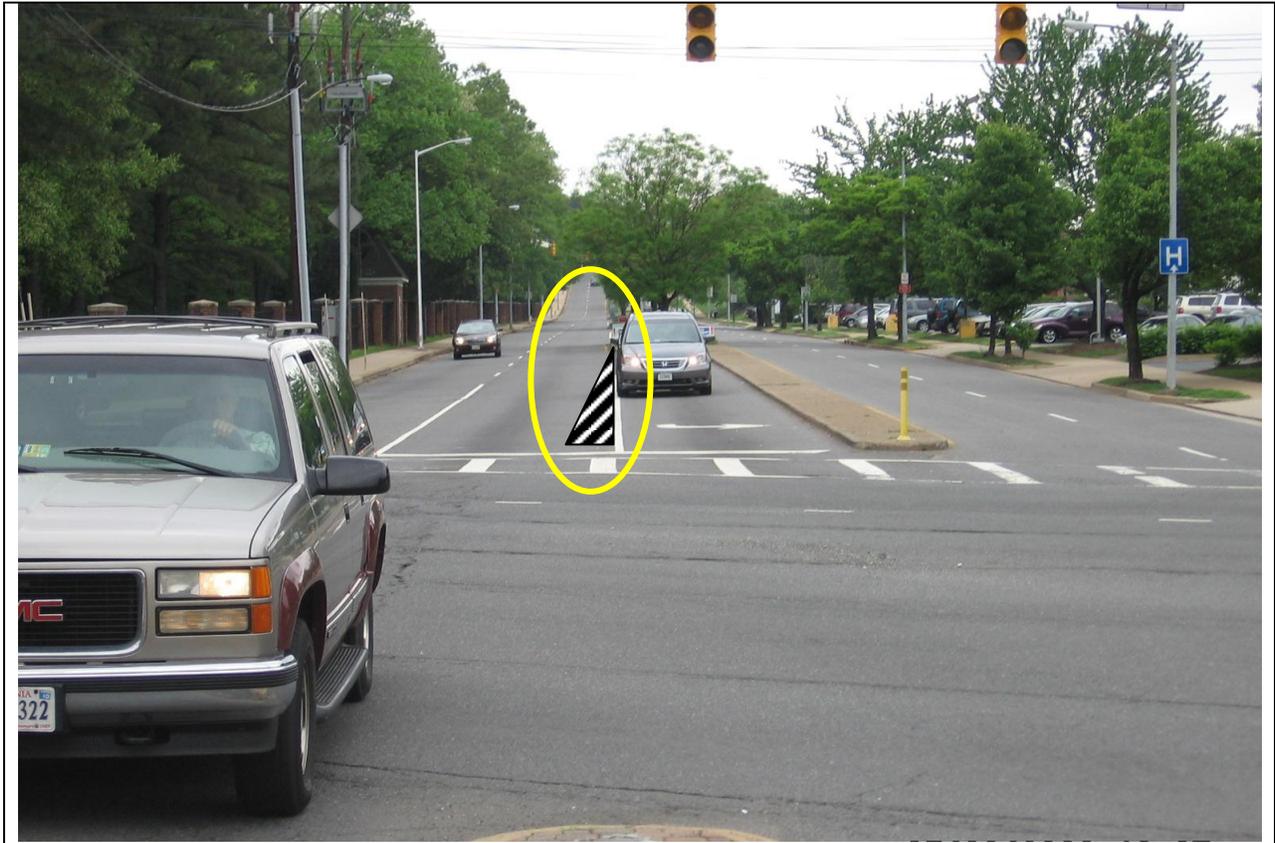
- Potential Improvement Measure 7



**Issues:** Pedestrians crossing sign is blocked for the northbound approach along Quaker Lane due to overgrown trees.

**Proposed Improvement:** Trim trees placed along Quaker Lane northbound approach, particularly near the pedestrian crossing signs.

- Potential Improvement Measure 8



**Issues:** Braddock Road eastbound approach at the intersection with Quaker Lane does not exactly align with the downstream receiving lanes at the intersection with King Street. There exists an offset where driver has to make a slight right turn maneuver in order to properly travel along the receiving lanes.

**Proposed Improvement:** Placing a lane Marking in an approach gore with triangular shape to adjust the offset along the eastbound approach at the intersection with Quaker Lane would help vehicle to position at the correct location before entering the intersection.

- As for the red light violation related crashes, provision of additional red clearance interval time at this intersection, similar to improvement measures mentioned for the King St and Quaker Lane intersection, may help in reducing the number of angle crashes.

**Potential Short-term Improvements at King Street / Braddock Road Intersection**

Based on the field review, following list provides some potential short-term improvement measures that would likely improve vehicular and pedestrian safety at the intersection of King Street and Braddock Road.

- Potential Improvement Measure 9

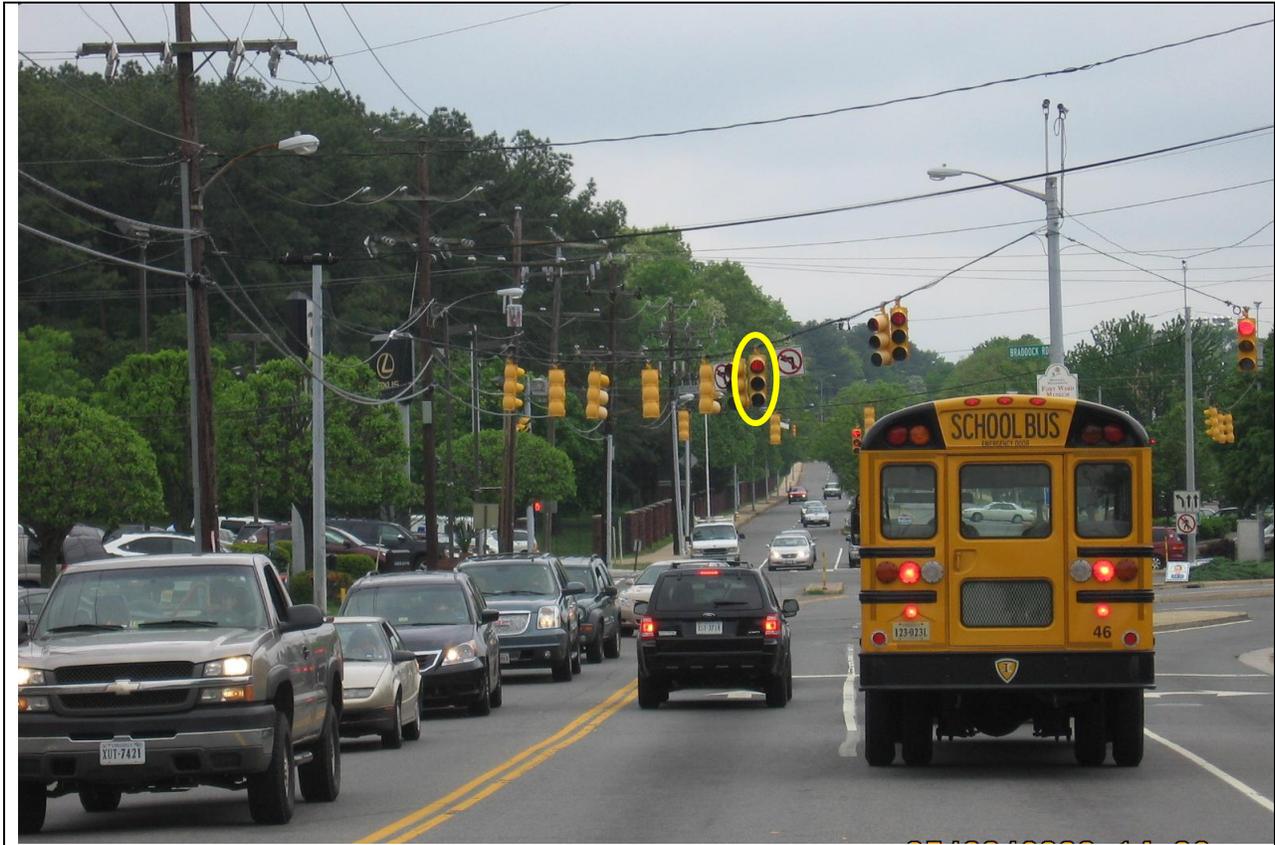


**Issues:** No crosswalks are provided along any of the legs at this intersection, while there are frequent pedestrian activities and jaywalking that is occurring in this vicinity. Also, on the southeast quadrant of the intersection, the accessible ramp along the east side of King Street is located behind the stop bar.

**Proposed Improvement:** Addition of crosswalks needs to be considered along the east and south legs of this intersection. The added crosswalks would protect the pedestrians taking the shortest path between the commercial developments areas and TC Williams High School, as well as residential units located nearby.

-

- Potential Improvement Measure 10



**Issues:** Since signal heads for both the northbound and westbound approaches are placed along the same wire in close proximity, louvers are placed at the signal heads for the westbound approach to prevent the drivers of the northbound approach from mistaking westbound signal head as signal head for northbound. Placement of these louvers for the westbound phase, especially during the red phase, is not clearly visible for the westbound approach until they approach close to the intersection.

**Proposed Improvement:** Measures would need to be taken to improve the visibility of the red indication of the signal heads such as replacement of the red signal heads or adjustments to the existing louvers.

Additional safety-related observations made and potential improvement measures identified at the vicinity of the King Street / Braddock Road/ Quaker Lane intersection area include:

- Potential Improvement Measure 11



**Issues:** Heavy school bus traffic stopping at bus stops resulted in through traffic queue spillback into adjacent intersections, especially along Braddock Road near the intersection with Radford Street and Kenwood Avenue, where only one through lane is provided for the eastbound approach until they approach close to the intersection.

**Proposed Improvement:** Widening to two lanes and providing clear lane markings for these approaches would be one consideration in terms of improving the operations.

- Potential Improvement Measure 12



**Issues:** During PM period when the school classes are ending, all of the school buses exiting from TC Williams High School are routed to travel along King Street eastbound and make a left turn onto Kenwood Avenue. Also, there is no protected left turn from King Street to Kenwood Avenue.

**Proposed Improvement:** Placing a protected left turn phase from King Street to Kenwood Avenue is anticipated to help the operations at this intersection.

- Potential Improvement Measure 13



**Issues:** At the intersection of Braddock Street / Kenwood Avenue, no lane markings are provided along westbound and northbound approaches. This results in back up along the Kenwood Avenue northbound approach and the King Street eastbound approach since signals at Braddock Road / Kenwood Avenue intersection and King Street / Kenwood Avenue serve as constraints for these particular movements.

**Proposed Improvement:** Prohibiting parking along immediate vicinity of the intersection and placing a separate lane marking for left and through movement at Braddock Street / Kenwood Avenue intersection is anticipated to help the operations at this intersection.

## **8.2. Long Term Service Road Improvements**

One concept for longer-term improvement to the service road would be to terminate the western portion of the service road at the western end of the Bradlee Shopping Plaza. Two options exist for this concept. The first would be to completely sever the service road towards Dearing Street from the shopping plaza. This would reconfigure the service road into a cul-de-sac, and all residents residing along the service road (3 buildings) would use Dearing Street to access King Street.

The second option would be to terminate the service road at the westerly boundary of the shopping center, to provide access only to the shopping center. The service road would not continue beyond that point. To provide either reconfiguration, a second direct access to King Street would be needed to allow for eastbound buses to enter the transit center and westbound buses to exit and return to King Street. This would require a new signal on King Street, which would be located between two existing signals, which are only 1,000 feet apart. Normally, such signal spacing would be undesirable, however the signal could be limited to serve transit vehicles only. It can also be considered that this intersection could provide a second access point into the shopping center, which would divert vehicles from the first access point and spread the traffic to multiple points. The signal can be coordinated with the signal at King Street / Taylor Street / Bradlee Shopping Center so that it would not impact the progression of King Street through traffic. Both options would likely require significant modifications to the existing shopping center, as it is undesirable to have an internal drive converted into major access point on King Street. The internal drive currently provides parking on both sides and no clear pedestrian control is provided. For these reasons, any major reconfiguration of the service road should be coordinated with redevelopment / reconfiguration of the shopping center.

## **8.3. Road-Diet along Quaker Lane**

The road-diet concept considered along Quaker Lane would reconfigure the existing undivided four-lane facility into a two-lane facility with a two-way left-turn lane as the center lane. This reconfiguration would reduce the number of through lanes to one for both northbound and southbound directions of Quaker Lane, between Braddock Road to the north and Duke Street to the south. . The road-diet would include reconfiguring the existing undivided four-lane facility into a two-lane facility with a two-way left turn lane as the center lane as shown in **Figure 24**.

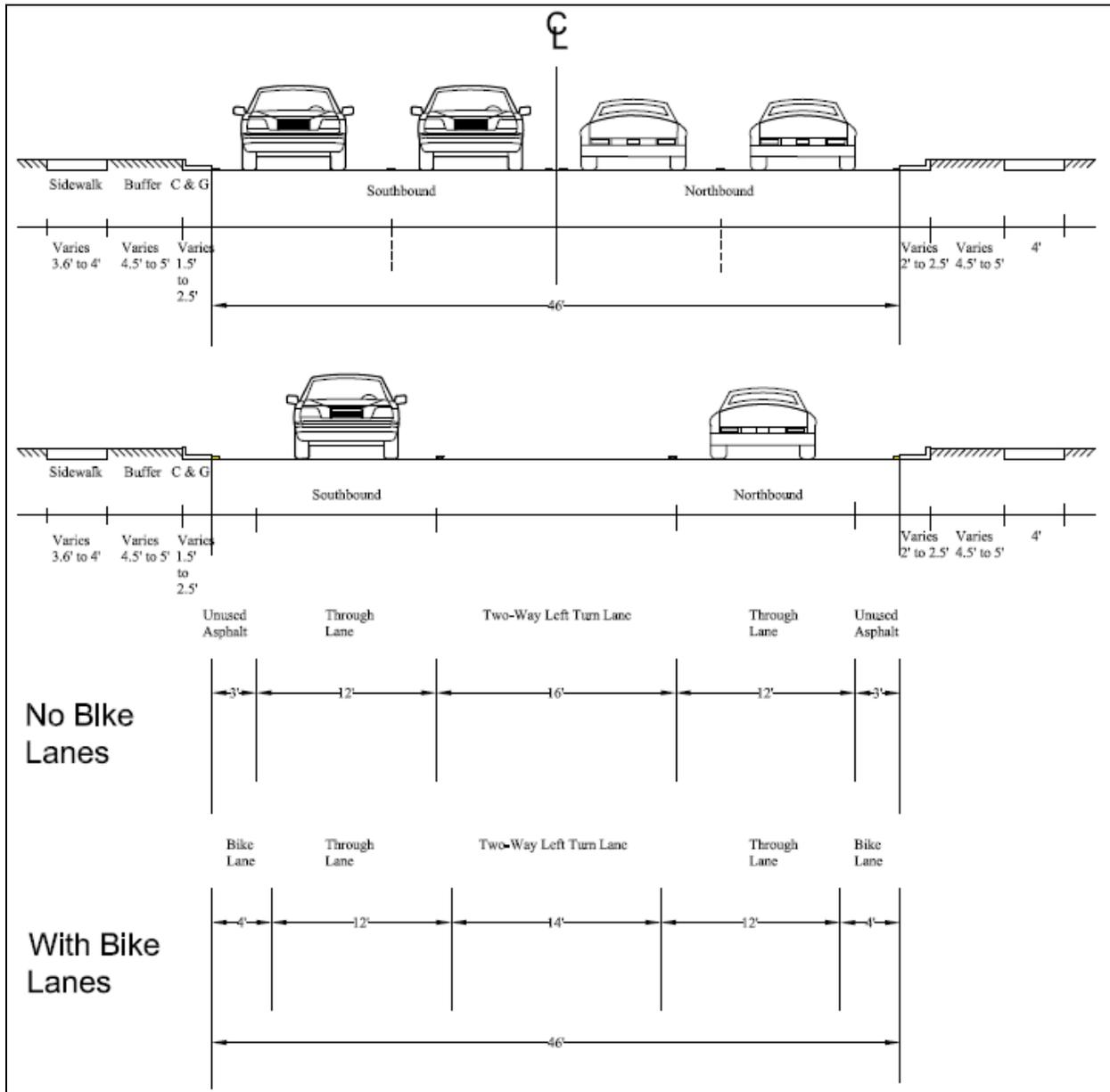


Figure 24: Road-Diet Improvement Concepts

Based on the stealth speed survey as previously presented in **Table 3: Stealth Speed Survey**, it was found that the average speed along Quaker Lane northbound between Duke Street and Seminary Road was higher than the posted speed limit by 5 mph while Quaker Lane southbound between King Street and Seminary Road was higher by 18 mph. This finding supports the need for either stricter traffic control enforcement or placing traffic calming measures along Quaker Lane to slow

traffic down. Implementation of a road-diet concept could effectively and permanently decrease travel speeds along this corridor, which could result in improved safety for drivers, pedestrians, and cyclists. In order to determine any impacts to traffic operations, micro-simulation traffic analyses were performed using CORSIM for the weekday morning, weekday evening, and Saturday peak hour conditions. The “before” and “after” conditions were tested for each time period.

The simulation analysis results suggest that increased congestion would result along Quaker Lane in the northbound direction during the morning peak hour and in the southbound direction during the weekday evening peak hour. It is anticipated that during traffic flows on Saturday, that no increase degradation to traffic flows would result due to the implementation of the road diet, as projected vehicular demand is not as high as the weekday peak hours. **Figure 25** and **Table 30** presents the summary of the road diet analysis. During the PM peak hour conditions, slight turbulence would be expected at the merge point along Quaker Lane southbound just south of Braddock Road where the lane reduces from two to one (2 to 1) lane and very little merge difficulty occurs when no queue spillback from the downstream intersection are present. However, the problem would be most noticeable when the back of the queue spills back to the point of the lane drop, as most vehicles in the right lane do not permit vehicles in the left lane to merge.

Therefore, the road-diet measures analyzed would result in negative impacts for traffic operations along the corridor during the weekday commuting periods. Generally, the effects of the road-diet would be longer queues and lower vehicle throughput in the peak direction along Quaker Lane, due to the reduction of roadway capacity.

Some other factors should be considered in implementing the Road Diet. The analysis has shown that congestion would increase in the future if the road diet is implemented. This could result in a diversion of traffic onto other roadways, including the adjacent local roads along Quaker Lane, resulting in neighborhood cut-through traffic increases. Additionally, drivers exiting from driveways along Quaker Lane are likely to experience increased difficulty finding gaps in traffic flow during peak periods. However, it should be noted that the road-diet measures would be expected to meet the goal of slowing traffic down on Quaker Lane. Therefore, this concept is heavily dependent on the need to weigh the inevitable reduction in peak hour capacity versus the desire to slow the traffic on Quaker Lane.

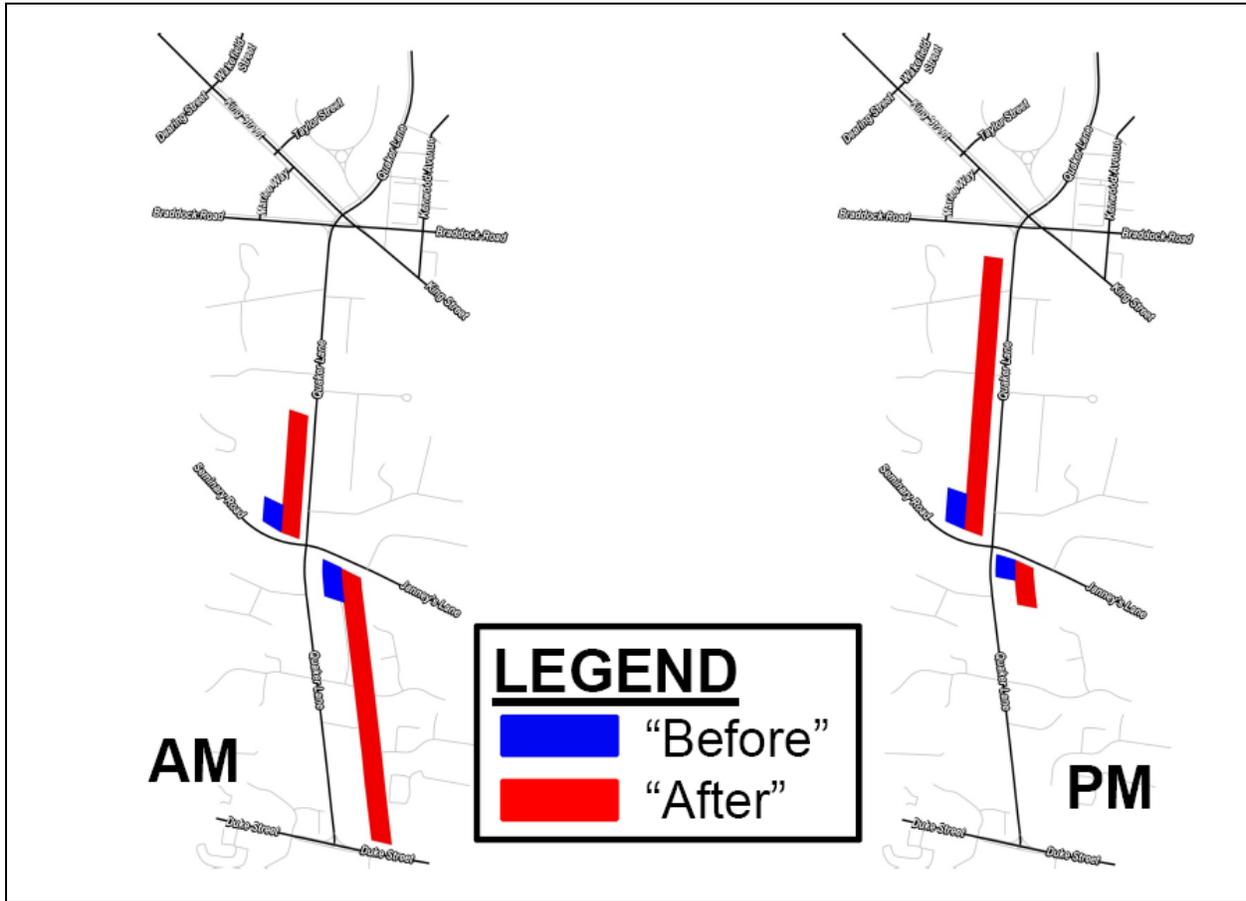


Figure 25: Road Diet Analysis - Queue Length Comparison

**Table 30: Summary of Road Diet Analysis**

|                                                             | <b>AM Peak Hour</b>                                                                                                                                                                                                                                                                                                           | <b>PM Peak Hour</b>                                                                                                                    |
|-------------------------------------------------------------|-------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------------|----------------------------------------------------------------------------------------------------------------------------------------|
| Traffic Flow Impacts                                        | Congestion would occur in the northbound direction from Duke Street to Seminary Road / Janneys Lane                                                                                                                                                                                                                           | Congestion would occur in the southbound direction from Braddock Road to Seminary Road / Janneys Lane                                  |
| Anticipated Queues                                          | Queue would extend in the northbound approach at the traffic signal with Seminary Road / Janneys Lane and spill back to Duke Street                                                                                                                                                                                           | Queue would extend in the southbound direction at the traffic signal with Seminary Road / Janneys Lane and spill back to Braddock Road |
| Unserved traffic                                            | Approximately 300 northbound vehicles would not be processed through this intersection (total of 20 percent unserved)                                                                                                                                                                                                         | Approximately 320 southbound vehicles would not be processed through this intersection (27 percent unserved)                           |
| Impacts to the side streets and driveways along Quaker Lane | During the weekday morning peak period, drivers on residential side streets south of Seminary Road / Janneys Lane would experience difficulty exiting their neighborhoods due to congestion along Quaker Lane. The same issue would occur on the residential side streets to the north during the weekday evening peak period |                                                                                                                                        |

## 9. Improvement Costs

### 9.1. Conceptual Alternative 1

The areas affected by the Conceptual Alternative 1 improvements would require some Right-of-Way (ROW) acquisitions and result in conflicts with the existing utilities. The areas affected are as follows:

- Along the westbound approach on Braddock Road, east of the Braddock Road / King Street intersection due to the lane shifts to the north.
  - o ROW acquisition of approximately 1,770 square feet.
  - o Utilities Conflict
    - Power – ROW acquisition requires relocation of two (2) power poles and approximately 250 feet of potential conflict with the existing power line due to the lane widening and relocation of the sidewalk to the north.
    - Water – approximately 250 feet of potential impacts to the existing water line.
- Along the departure lanes (eastbound) on Braddock Road east of the Braddock Road / King Street intersection due to the widening to two lanes.
  - o ROW acquisition of approximately 950 square feet.
  - o Utilities Conflict
    - Power – ROW acquisition requires relocation of two power poles and approximately 170 feet of potential conflict with the existing power line due to the lane widening and relocation of the sidewalk to the south.
    - Gas – approximately 170 feet of potential impact to the existing gas line.
- Along the departure lanes (south-eastbound) on King Street, southeast of the Braddock Road / King Street intersection due to the lane shift of the through lanes. The lane shift is required to accommodate an additional left-turn lane for the south-eastbound direction at this intersection.
  - o ROW acquisition of approximately 150 square feet.
  - o Utilities – no conflicts.

A order of magnitude costs for all alternatives (planning level costs) for the improvements specified above is summarized in **Table 31**. A detailed breakdown of the specific improvements at each intersection is included in the Appendix. The costs include only the physical improvements of the roadway. Other costs would also needed to be considered, which are Preliminary Engineering

(designing of the improvements), Construction Contingency (reserves for unexpected construction conditions), and Right-of-Way (ROW) costs. The Virginia Department of Transportation (VDOT) has factors that are applied to the improvement costs that account for each of these three other costs. The values used for Northern Virginia are 0.3, 0.2 and 0.75 for the Preliminary Engineering, Construction Contingency, and ROW costs, respectively. For example, if a physical improvement cost is \$100,000, it can be expected that preliminary engineering costs would be in the order of \$30,000, construction contingency would be in the order of \$20,000 and the right-of-way cost would be in the order of \$75,000; the total estimated cost would be \$225,000. The cost estimates were prepared based on “RS Means 2006 Heavy Construction Cost Data” reference manual and with the Northern Virginia District cost average table published by VDOT.

**Table 31: Cost Estimate – Conceptual Alternative 1**

| <b>Costs</b>                 | <b>Estimated Cost (\$)</b> |
|------------------------------|----------------------------|
| Improvements Cost            | \$ 844,400                 |
| Preliminary Engineering Cost | \$ 253,300                 |
| Construction Contingency     | \$ 168,900                 |
| ROW Cost                     | \$ 633,300                 |
| <b>Total Estimated Cost</b>  | <b>\$ 1,899,900</b>        |

**9.2. Conceptual Alternative 2**

The areas affected by the Conceptual Alternative 2 improvement would require some Right-of-Way (ROW) acquisition and result in conflicts with the existing utilities. The areas affected are as follows:

- Along the north-westbound approach on King Street, northeast of the King Street / Quaker Lane intersection due to the widening required accommodating the dual left turn lanes.
  - o Additional ROW acquisition of approximately 1,050 square feet.
  - o Utilities Conflict
    - Power line – ROW acquisition requires relocation of one signal pole.
    - Water – approximately 140 ft of potential impacts to the existing water line.
- Along the departure lanes (eastbound) on Braddock Road east of the Braddock Road / King Street intersection due to the widening to two lanes.
  - o ROW acquisition of approximately 970 square feet.

- Utilities Conflict
  - Power – ROW acquisition requires relocation of two (2) power poles and approximately 170 feet of potential conflict with the existing power line due to the lane widening and relocation of the sidewalk to the south.
  - Gas – approximately 170 feet potential impact to the existing gas line.
- Along the departure lanes (south-eastbound) on King Street, southeast of the Braddock Road / King Street intersection due to the lane shift of the through lanes. The lane shift is required in order to accommodate an additional left turn lane for the south-eastbound direction at this intersection.
  - ROW acquisition of approximately 70 square feet.
  - Utilities – no conflicts.

A preliminary cost estimate (planning level costs) for the improvements specified are summarized in **Table 32**. A detailed breakdown of the specific improvements at each intersection is included in the Appendix. The values of the factors are the same as discussed above. The cost estimate for the improvements assumed under Conceptual Alternative 2 is higher than that estimated for Conceptual Alternative 1.

**Table 32: Cost Estimate – Conceptual Alternative 2**

| <b>Costs</b>                 | <b>Estimated Cost (\$)</b> |
|------------------------------|----------------------------|
| Improvements Cost            | \$ 859,700                 |
| Preliminary Engineering Cost | \$ 257,900                 |
| Construction Contingency     | \$ 171,900                 |
| ROW Cost                     | \$ 644,800                 |
| <b>Total Estimated Cost</b>  | <b>\$ 1,934,300</b>        |

**9.3. Service Road and Transit Improvements**

Improvements proposed at the King Street / Taylor Street intersection would be feasible under the existing ROW and there would be no need to acquire any additional ROW. In addition, there would be no utility conflicts when implementing the improvements.

A preliminary cost estimate (planning level costs) for the improvements specified in the *Service Road and Transit Improvements* section are summarized in **Table 33**. A detailed breakdown of the specific improvements is also included in the Appendix. The values of the factors are the same as discussed above. As the service road is within the existing public ROW, no ROW acquisition would be needed for the construction of the transit center and modification to the service road.

**Table 33: Cost Estimate – Service Roads and Transit Improvements**

| Costs                        | Estimated Cost (\$) |
|------------------------------|---------------------|
| Improvements Cost            | \$ 326,500          |
| Preliminary Engineering Cost | \$ 97,900           |
| Construction Contingency     | \$ 65,300           |
| <b>Total Estimated Cost</b>  | <b>\$ 489,700</b>   |

**9.4. Short-Term Improvements**

Improvements proposed at the intersections of King Street / Braddock Road / Quaker Lane and at King Street / Wakefield Street / Dearing Street would be feasible under the existing ROW and there would be no need to acquire any additional ROW. In addition, there would be no utility conflicts when implementing the improvements. Bus shelters and bus pullout areas could also be provided with little or no ROW impact. A preliminary cost estimate (planning level costs) for these improvements are summarized in **Table 34**. A detailed breakdown of the specific improvements is included in the Appendix. The values of the factors are the same as discussed above. As the service road is within the existing public ROW, no ROW acquisition would be needed for these improvements.

**Table 34: Cost Estimate – Short-Term Improvements**

| Costs                        | Estimated Cost (\$) |
|------------------------------|---------------------|
| Improvements Cost            | \$ 22,000           |
| Preliminary Engineering Cost | \$ 6,600            |
| Construction Contingency     | \$ 4,400            |
| <b>Total Estimated Cost</b>  | <b>\$ 33,000</b>    |

Note: Excludes bus shelters and bus pullout areas

The typical order-of-magnitude cost of a bus shelter is approximately \$8,000, which includes the shelter, concrete pad and the installation costs. ROW or easement costs would be additional. Bus pullout areas'

order-of-magnitude costs will depend on actual size of the pullout area, but would range from \$50,000 to \$150,000, plus ROW costs.

**9.5. Road-Diet along Quaker Lane**

Construction of the road-diet concept along Quaker Lane would be feasible under the existing public ROW and there would be no need to acquire any additional ROW. In addition, there would be no utility conflicts when implementing the improvements.

A preliminary cost estimate (planning level costs) for the improvements specified in the *Road-Diet along Quaker Lane* section are summarized in **Table 35**. A detailed breakdown of the specific improvements is included in the Appendix. The values of the factors are the same as discussed above. Because the cross-section of Quaker Lane would not need to be widened and the improvements would remain within the physical footprint of the roadway, no ROW acquisition would be needed.

**Table 35: Cost Estimate – Road-Diet along Quaker Lane**

| <b>Costs</b>                 | <b>Estimated Cost (\$)</b> |
|------------------------------|----------------------------|
| Improvements Cost            | \$ 103,400                 |
| Preliminary Engineering Cost | \$ 31,000                  |
| Construction Contingency     | \$ 20,700                  |
| <b>Total Estimated Cost</b>  | <b>\$ 155,100</b>          |

## **10. Summary and Findings**

### **10.1. Summary of the Conceptual Alternatives**

This report has documented the existing and future conditions in the study area for the Route 7 Spot Improvements – Braddock Road, King Street and Quaker Lane Traffic Study. The corridors examined include King Street from Wakefield and Dearing Streets; Quaker Lane between Duke Street and 36<sup>th</sup> Street (north of King Street); and Braddock Road within the vicinity of Quaker Lane. A number of potential roadway improvements and geometric reconfigurations were evaluated. The analysis was completed in a two-tier approach. First, all concepts were evaluated using the traffic analysis software Synchro, and the results were then presented forward. Second, based on the public comments, selected concepts were carried forward for further analysis, using the traffic analysis software CORSIM as warranted, and planning-level cost estimates were developed. The improvements that have been analyzed and evaluated include the following:

1. **Short Term Improvements** – Safety improvements to the intersection of King Street / Dearing Street / Wakefield Street, and wayfinding improvements at the intersection of King Street / Braddock Road / Quaker Lane. Bus Shelters and pullout areas could also be throughout the study area to encourage more riders.
2. **Transit Center** – Construct a transit center on the service road in front of the Bradlee Shopping Center. This would entail closing a segment of the service road to through traffic. The improvements would simplify the traffic operations of the intersection of the service road at the signal on King Street by reducing the number of movements at the intersection.
3. **Alternative 1** – Add a second left-turn lane at four locations within the intersection of King Street / Braddock Road / Quaker Lane, including eastbound King Street at Braddock Road and Quaker Lane, northbound Quaker Lane at King Street, and westbound Braddock Road at Quaker Lane. These improvements would also include the realignment of Braddock Road at King Street to accommodate the addition of the left turn lanes. The improvements would increase the left-turn capacity for these heavy movements. The service road access onto Quaker Lane would be closed.
4. **Alternative 2** – Close the segment of Braddock Road between King Street and Quaker Lane; affected traffic would be rerouted to King Street and Quaker Lane. Additional left-turn lanes

would be provided for King Street traffic and the service road access onto Quaker Lane would be closed. This reconfiguration would simplify the operations at the signal.

5. **Road-Diet along Quaker Lane** – The cross-section of Quaker Lane would be reconfigured from a four-lane to a three-lane cross-section, where the center lane would be a two-way left-turn lane. The signalized intersections would not be modified, other than at Seminary Road / Janneys Lane where the number of through lanes would decrease from four to two lanes. This improvement would help reduce travel speeds along Quaker Lane, and provide left-turn lanes into residential side streets.

Preliminary order-of-magnitude costs were developed for the concepts and are presented in **Table 36**. It should be noted that these cost estimates are not detailed cost estimates but planning-level estimates only. Further improvements, not included in the table below, would include providing bus shelters and bus-pullout areas.

**Table 36: Preliminary Order-of-Magnitude Cost Estimates**

| Costs                              | Estimated Cost (\$) |
|------------------------------------|---------------------|
| <b>Conceptual Alternative 1</b>    | <b>\$ 1,899,900</b> |
| <b>Conceptual Alternative 2</b>    | <b>\$ 1,934,300</b> |
| <b>Transit Center</b>              | <b>\$ 489,700</b>   |
| <b>Road Diet along Quaker Lane</b> | <b>\$ 155,100</b>   |
| <b>Short Term Improvements</b>     | <b>\$ 33,000</b>    |

Note: Either Alternative 1 or 2 would be selected. Costs have been rounded to nearest hundred.

The improvements can be divided into short-term (less than 5 years) and long-term (more than 5 years) projects that can be implemented as funding becomes available. The short-term improvements, as described above, would help alleviate safety concerns at the King Street / Dearing Street / Wakefield Street intersection, and improve wayfinding at the intersection of King Street / Braddock Road / Quaker Lane. It would also include adding bus shelters and bus pullout areas. The transit center could be implemented within the near future, depending on coordination with WMATA Metrobus and Alexandria DASH services.

The road-diet concept could be implemented within either the short-term or the long-term. This project’s ultimate timeline should consider other nearby roadway improvements, such as the ongoing

improvements along Telegraph Road, as it influences travel patterns along Quaker Lane. This concept would encourage traffic calming with reduced roadway capacity; however, it should be expected that the roadway would not be able to accommodate the peak direction of traffic during the weekday morning and evening peak hours. This capacity constraint may encourage trip diversion onto other roadways.

The larger improvements, as identified within this chapter, at the intersection of King Street / Braddock Road / Quaker Lane could be implemented within the 10-year horizon. As constructing the improvements would have a minor to moderate impact on traffic, and are relatively moderate in terms of costs (in comparison to other larger improvements), either conceptual alternative could be selected. Both conceptual alternatives have right-of-way impacts; some property acquisition would be needed to obtain the necessary rights-of-way for implementing the improvements. In terms of operations, Conceptual Alternative 1 is expected to perform better than Conceptual Alternative 2. However, Conceptual Alternative 2 would simplify the operations of the intersection by reducing the number of movements at this complicated intersection while still providing connections from all directions.

Both conceptual alternatives would close the Bradlee Shopping Center service road access to Quaker Lane. The closure, coupled with the potential construction of a transit center, would revert the service road into a local access roadway for the businesses along King Street, rather than a parallel roadway to King Street, with potential for cut-through traffic.

Longer-term reconfiguration of the service road between the Bradlee Shopping Center and Dearing Street would need to be tied to the redevelopment or reconfiguration of the Bradlee Shopping Center. The service road could be severed from the shopping center and a new connection onto King Street could be provided. This would sever the link between Dearing Street and the shopping center, but still provide access to the residential units to the east of Dearing Street. A new access point onto King Street could not be implemented under the existing configuration due to the configuration of the parking area.

## **10.2. Findings**

The short-term improvements and transit center option could be implemented with relative ease and with little impact to existing traffic flows, other than to the traffic on the King Street service road. Traffic

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on the service road would then be forced to use King Street for non-local trips. However, these improvements would enhance the flow entering and exiting the Bradlee Shopping Center.

The road-diet concept could be implemented relatively quickly, but caution should be exercised. After completion of this project, Quaker Lane would likely not be capable of accommodating the peak direction of travel in both the weekday morning and evening peak hours. This concept would primarily serve to reduce travel speeds on Quaker Lane, at the expense of regional mobility for daily commuters within the study area.

Conceptual Alternative 1 is expected to provide greater operational improvement to the King Street / Braddock Road / Quaker Lane intersections than Conceptual Alternative 2. Additionally, preliminary cost estimates indicate that Alternative 1 should cost slightly less than Alternative 2. Finally, Alternative 1 would be most familiar to drivers, because it does not require any traffic diversion, and the proposed Alternative 1 improvements would increase the capacity for the heavy projected left-turn movements.

## **Appendices**

## **Appendix 1: Existing (2008) and 2020 No-Build Volumes**

## Appendix 1: Existing (2008) and 2020 No-Build Volumes

**Table A-1: 2008 Existing Turn Movement Volumes – AM Peak Hour**

| Intersection Location            | NB  |     |     | SB  |     |     | EB  |      |     | WB  |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|------|
|                                  | L   | T   | R   | L   | T   | R   | L   | T    | R   | L   | T   | R    |
| King St/Taylor St                | 57  | 19  | 24  | 17  | 21  | 61  | 5   | 716  | 59  | 200 | 793 | 10   |
| King St/Quaker Ln                | 253 | 669 | 0   | 0   | 433 | 201 | 248 | 639  | 131 | 0   | 549 | 19   |
| King St (e-w) / Braddock Rd n/s) | 0   | 510 | 267 | 0   | 399 | 265 | 204 | 423  | 0   | 0   | 291 | 0    |
| King St/Kenwood St               | 0   | 0   | 0   | 200 | 0   | 20  | 125 | 600  | 0   | 0   | 280 | 240  |
| Braddock Rd/Marlee Way           | 0   | 0   | 0   | 54  | 0   | 66  | 140 | 816  | 0   | 0   | 417 | 50   |
| Braddock Rd/Quaker Ln            | 106 | 791 | 131 | 0   | 517 | 110 | 131 | 646  | 125 | 87  | 312 | 0    |
| Braddock Rd/Kenwood St           | 78  | 235 | 71  | 122 | 152 | 45  | 11  | 663  | 12  | 34  | 531 | 69   |
| Quaker Ln/Seminary Rd/Janney St  | 525 | 773 | 26  | 104 | 463 | 78  | 99  | 251  | 214 | 112 | 324 | 103  |
| Quaker Ln/Duke St                | 0   | 0   | 0   | 709 | 0   | 95  | 335 | 1748 | 0   | 0   | 794 | 1125 |

**Table A-2: 2008 Existing Turn Movement Volumes – PM Peak Hour**

| Intersection Location            | NB  |     |     | SB  |     |     | EB  |      |     | WB  |      |     |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|------|-----|
|                                  | L   | T   | R   | L   | T   | R   | L   | T    | R   | L   | T    | R   |
| King St/Taylor St                | 64  | 25  | 10  | 3   | 42  | 8   | 10  | 795  | 82  | 242 | 911  | 11  |
| King St/Quaker Ln                | 204 | 526 | 0   | 0   | 845 | 262 | 162 | 707  | 134 | 0   | 698  | 49  |
| King St (e-w) / Braddock Rd n/s) | 0   | 453 | 220 | 0   | 578 | 159 | 181 | 512  | 0   | 0   | 572  | 0   |
| King St/Kenwood St               | 0   | 0   | 0   | 178 | 0   | 8   | 25  | 698  | 0   | 0   | 598  | 208 |
| Braddock Rd/Marlee Way           | 0   | 0   | 0   | 101 | 0   | 102 | 69  | 755  | 0   | 0   | 622  | 51  |
| Braddock Rd/Quaker Ln            | 79  | 588 | 105 | 0   | 847 | 164 | 142 | 568  | 162 | 133 | 445  | 0   |
| Braddock Rd/Kenwood St           | 53  | 162 | 25  | 111 | 194 | 54  | 12  | 573  | 7   | 13  | 630  | 76  |
| Quaker Ln/Seminary Rd/Janney St  | 274 | 578 | 29  | 175 | 566 | 90  | 93  | 310  | 267 | 27  | 292  | 180 |
| Quaker Ln/Duke St                | 0   | 0   | 0   | 597 | 0   | 37  | 332 | 1045 | 0   | 0   | 1376 | 687 |

**Table A-3: 2008 Existing Turn Movement Volumes – Saturday Peak Hour**

| Intersection Location            | NB  |     |    | SB  |     |     | EB  |      |     | WB  |      |     |
|----------------------------------|-----|-----|----|-----|-----|-----|-----|------|-----|-----|------|-----|
|                                  | L   | T   | R  | L   | T   | R   | L   | T    | R   | L   | T    | R   |
| King St/Taylor St                | 114 | 84  | 16 | 5   | 61  | 25  | 26  | 764  | 114 | 331 | 788  | 11  |
| King St/Quaker Ln                | 180 | 484 | 7  | 0   | 414 | 216 | 221 | 595  | 170 | 0   | 734  | 31  |
| King St (e-w) / Braddock Rd n/s) | 0   | 254 | 91 | 0   | 273 | 279 | 199 | 433  | 0   | 0   | 500  | 0   |
| King St/Kenwood St               | 0   | 0   | 0  | 157 | 0   | 15  | 14  | 524  | 0   | 0   | 480  | 20  |
| Braddock Rd/Marlee Way           | 0   | 0   | 0  | 82  | 0   | 76  | 55  | 341  | 0   | 0   | 324  | 81  |
| Braddock Rd/Quaker Ln            | 95  | 563 | 94 | 0   | 567 | 77  | 108 | 251  | 123 | 69  | 204  | 0   |
| Braddock Rd/Kenwood St           | 46  | 106 | 19 | 107 | 104 | 55  | 26  | 413  | 4   | 26  | 442  | 51  |
| Quaker Ln/Seminary Rd/Janney St  | 173 | 577 | 19 | 109 | 550 | 48  | 48  | 154  | 221 | 16  | 121  | 93  |
| Quaker Ln/Duke St                | 0   | 0   | 0  | 630 | 0   | 135 | 184 | 1152 | 0   | 0   | 1030 | 573 |

**Table A-4: 2008 Existing Link Volumes - AM Peak Hour**

| Intersection Location            | Approach Volumes |     |      |      | Exit Volumes |       |      |      |
|----------------------------------|------------------|-----|------|------|--------------|-------|------|------|
|                                  | NB               | SB  | EB   | WB   | North        | South | East | West |
| King St/Taylor St                | 100              | 99  | 780  | 1003 | 34           | 280   | 757  | 911  |
| King St/Quaker Ln                | 922              | 634 | 1018 | 568  | 936          | 564   | 639  | 1003 |
| King St (e-w) / Braddock Rd n/s) | 777              | 664 | 627  | 291  | 714          | 399   | 690  | 556  |
| King St/Kenwood St               | 0                | 220 | 725  | 520  | 365          | 0     | 800  | 300  |
| Braddock Rd/Marlee Way           | 0                | 120 | 956  | 467  | 190          | 0     | 870  | 483  |
| Braddock Rd/Quaker Ln            | 1028             | 627 | 902  | 399  | 922          | 729   | 777  | 528  |
| Braddock Rd/Kenwood St           | 384              | 319 | 686  | 634  | 315          | 198   | 856  | 654  |
| Quaker Ln/Seminary Rd/Janney St  | 1324             | 645 | 564  | 539  | 975          | 789   | 381  | 927  |
| Quaker Ln/Duke St                | 0                | 804 | 2083 | 1919 | 1460         | 0     | 2457 | 889  |

**Table A-5: 2008 Existing Link Volumes - PM Peak Hour**

| Intersection Location            | Approach Volumes |      |      |      | Exit Volumes |       |      |      |
|----------------------------------|------------------|------|------|------|--------------|-------|------|------|
|                                  | NB               | SB   | EB   | WB   | North        | South | East | West |
| King St/Taylor St                | 99               | 53   | 887  | 1164 | 46           | 366   | 808  | 983  |
| King St/Quaker Ln                | 730              | 1107 | 1003 | 747  | 737          | 979   | 707  | 1164 |
| King St (e-w) / Braddock Rd n/s) | 673              | 737  | 693  | 572  | 634          | 578   | 732  | 731  |
| King St/Kenwood St               | 0                | 186  | 723  | 806  | 233          | 0     | 876  | 606  |
| Braddock Rd/Marlee Way           | 0                | 203  | 544  | 673  | 120          | 0     | 576  | 724  |
| Braddock Rd/Quaker Ln            | 772              | 1011 | 872  | 578  | 730          | 1142  | 673  | 688  |
| Braddock Rd/Kenwood St           | 240              | 359  | 592  | 719  | 250          | 214   | 709  | 737  |
| Quaker Ln/Seminary Rd/Janney St  | 881              | 831  | 670  | 499  | 851          | 860   | 514  | 656  |
| Quaker Ln/Duke St                | 0                | 634  | 1377 | 2063 | 1019         | 0     | 1642 | 1413 |

**Table A-6: 2008 Existing Link Volumes - Saturday Peak Hour**

| Intersection Location            | Approach Volumes |     |      |      | Exit Volumes |       |      |      |
|----------------------------------|------------------|-----|------|------|--------------|-------|------|------|
|                                  | NB               | SB  | EB   | WB   | North        | South | East | West |
| King St/Taylor St                | 214              | 91  | 904  | 1130 | 121          | 506   | 785  | 927  |
| King St/Quaker Ln                | 671              | 630 | 986  | 765  | 736          | 584   | 602  | 1130 |
| King St (e-w) / Braddock Rd n/s) | 345              | 552 | 632  | 500  | 453          | 273   | 524  | 779  |
| King St/Kenwood St               | 0                | 172 | 547  | 575  | 117          | 0     | 690  | 487  |
| Braddock Rd/Marlee Way           | 0                | 158 | 396  | 405  | 136          | 0     | 423  | 400  |
| Braddock Rd/Quaker Ln            | 752              | 644 | 482  | 273  | 671          | 759   | 345  | 376  |
| Braddock Rd/Kenwood St           | 171              | 266 | 443  | 519  | 183          | 134   | 539  | 543  |
| Quaker Ln/Seminary Rd/Janney St  | 769              | 707 | 423  | 230  | 718          | 787   | 282  | 342  |
| Quaker Ln/Duke St                | 0                | 765 | 1336 | 1603 | 757          | 0     | 1782 | 1165 |

**Table A-7: 2020 No-Build Conditions Turn Movement Volumes – AM Peak Hour**

| Intersection Location            | NB  |     |     | SB  |     |     | EB  |      |     | WB  |     |      |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|-----|------|
|                                  | L   | T   | R   | L   | T   | R   | L   | T    | R   | L   | T   | R    |
| King St/Taylor St                | 64  | 21  | 27  | 19  | 24  | 69  | 6   | 807  | 66  | 205 | 953 | 6    |
| King St/Quaker Ln                | 332 | 756 | 0   | 0   | 488 | 226 | 279 | 720  | 148 | 0   | 606 | 21   |
| King St (e-w) / Braddock Rd n/s) | 0   | 584 | 301 | 0   | 439 | 299 | 229 | 455  | 0   | 0   | 333 | 0    |
| King St/Kenwood St               | 0   | 0   | 0   | 225 | 0   | 23  | 131 | 646  | 0   | 0   | 321 | 265  |
| Braddock Rd/Marlee Way           | 0   | 0   | 0   | 61  | 0   | 74  | 156 | 921  | 0   | 0   | 566 | 56   |
| Braddock Rd/Quaker Ln            | 119 | 940 | 156 | 0   | 583 | 123 | 148 | 729  | 141 | 92  | 347 | 0    |
| Braddock Rd/Kenwood St           | 88  | 265 | 80  | 137 | 171 | 51  | 12  | 747  | 14  | 38  | 598 | 78   |
| Quaker Ln/Seminary Rd/Janney St  | 611 | 871 | 37  | 148 | 522 | 91  | 112 | 357  | 241 | 126 | 377 | 116  |
| Quaker Ln/Duke St                | 0   | 0   | 0   | 799 | 0   | 112 | 377 | 1970 | 0   | 0   | 937 | 1268 |

**Table A-8: 2020 No-Build Conditions Turn Movement Volumes – PM Peak Hour**

| Intersection Location            | NB  |     |     | SB  |     |     | EB  |      |     | WB  |      |     |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|------|-----|
|                                  | L   | T   | R   | L   | T   | R   | L   | T    | R   | L   | T    | R   |
| King St/Taylor St                | 72  | 28  | 11  | 3   | 47  | 9   | 11  | 896  | 92  | 273 | 1027 | 12  |
| King St/Quaker Ln                | 255 | 567 | 0   | 0   | 949 | 282 | 189 | 780  | 161 | 0   | 775  | 37  |
| King St (e-w) / Braddock Rd n/s) | 0   | 511 | 248 | 0   | 648 | 159 | 181 | 580  | 0   | 0   | 632  | 0   |
| King St/Kenwood St               | 0   | 0   | 0   | 201 | 0   | 9   | 17  | 561  | 0   | 0   | 661  | 234 |
| Braddock Rd/Marlee Way           | 0   | 0   | 0   | 141 | 0   | 115 | 78  | 755  | 0   | 0   | 637  | 57  |
| Braddock Rd/Quaker Ln            | 89  | 662 | 164 | 0   | 955 | 184 | 160 | 595  | 183 | 232 | 411  | 0   |
| Braddock Rd/Kenwood St           | 60  | 183 | 28  | 125 | 219 | 61  | 14  | 646  | 8   | 15  | 710  | 86  |
| Quaker Ln/Seminary Rd/Janney St  | 330 | 651 | 38  | 230 | 638 | 108 | 105 | 407  | 301 | 30  | 351  | 203 |
| Quaker Ln/Duke St                | 0   | 0   | 0   | 673 | 0   | 42  | 374 | 1177 | 0   | 0   | 1550 | 774 |

**Table A-9: 2020 No-Build Conditions Turn Movement Volumes – Saturday Peak Hour**

| Intersection Location            | NB  |     |     | SB  |     |     | EB  |      |     | WB  |      |     |
|----------------------------------|-----|-----|-----|-----|-----|-----|-----|------|-----|-----|------|-----|
|                                  | L   | T   | R   | L   | T   | R   | L   | T    | R   | L   | T    | R   |
| King St/Taylor St                | 128 | 95  | 18  | 6   | 69  | 28  | 29  | 961  | 128 | 373 | 888  | 12  |
| King St/Quaker Ln                | 223 | 552 | 0   | 0   | 487 | 292 | 249 | 790  | 192 | 0   | 758  | 107 |
| King St (e-w) / Braddock Rd n/s) | 0   | 271 | 117 | 0   | 358 | 314 | 318 | 472  | 0   | 0   | 551  | 0   |
| King St/Kenwood St               | 0   | 0   | 0   | 177 | 0   | 17  | 16  | 780  | 0   | 0   | 532  | 116 |
| Braddock Rd/Marlee Way           | 0   | 0   | 0   | 102 | 0   | 86  | 62  | 496  | 0   | 0   | 406  | 90  |
| Braddock Rd/Quaker Ln            | 107 | 653 | 105 | 0   | 639 | 87  | 122 | 283  | 139 | 97  | 261  | 0   |
| Braddock Rd/Kenwood St           | 52  | 119 | 21  | 121 | 117 | 62  | 29  | 565  | 5   | 29  | 558  | 57  |
| Quaker Ln/Seminary Rd/Janney St  | 210 | 650 | 25  | 141 | 620 | 58  | 54  | 199  | 249 | 18  | 147  | 105 |
| Quaker Ln/Duke St                | 0   | 0   | 0   | 710 | 0   | 152 | 207 | 1298 | 0   | 0   | 1161 | 646 |

**Table A-10: 2020 No Build Conditions Link Volumes - AM Peak Hour**

| Intersection Location            | Approach Volumes |     |      |      | Exit Volumes |       |      |      |
|----------------------------------|------------------|-----|------|------|--------------|-------|------|------|
|                                  | NB               | SB  | EB   | WB   | North        | South | East | West |
| King St/Taylor St                | 112              | 112 | 879  | 1164 | 33           | 295   | 853  | 1086 |
| King St/Quaker Ln                | 1088             | 714 | 1147 | 627  | 1056         | 636   | 720  | 1164 |
| King St (e-w) / Braddock Rd n/s) | 885              | 738 | 684  | 333  | 813          | 439   | 756  | 632  |
| King St/Kenwood St               | 0                | 248 | 777  | 586  | 396          | 0     | 871  | 344  |
| Braddock Rd/Marlee Way           | 0                | 135 | 1077 | 622  | 212          | 0     | 982  | 640  |
| Braddock Rd/Quaker Ln            | 1215             | 706 | 1018 | 439  | 1088         | 816   | 885  | 589  |
| Braddock Rd/Kenwood St           | 433              | 359 | 773  | 714  | 355          | 223   | 964  | 737  |
| Quaker Ln/Seminary Rd/Janney St  | 1519             | 761 | 710  | 619  | 1099         | 889   | 542  | 1079 |
| Quaker Ln/Duke St                | 0                | 911 | 2347 | 2205 | 1645         | 0     | 2769 | 1049 |

**Table A-11: 2020 No Build Conditions Link Volumes - PM Peak Hour**

| Intersection Location            | Approach Volumes |      |      |      | Exit Volumes |       |      |      |
|----------------------------------|------------------|------|------|------|--------------|-------|------|------|
|                                  | NB               | SB   | EB   | WB   | North        | South | East | West |
| King St/Taylor St                | 111              | 59   | 999  | 1312 | 51           | 412   | 910  | 1108 |
| King St/Quaker Ln                | 822              | 1231 | 1130 | 812  | 793          | 1110  | 780  | 1312 |
| King St (e-w) / Braddock Rd n/s) | 759              | 807  | 761  | 632  | 692          | 648   | 828  | 791  |
| King St/Kenwood St               | 0                | 210  | 578  | 895  | 251          | 0     | 762  | 670  |
| Braddock Rd/Marlee Way           | 0                | 256  | 833  | 694  | 135          | 0     | 896  | 752  |
| Braddock Rd/Quaker Ln            | 915              | 1139 | 938  | 643  | 822          | 1370  | 759  | 684  |
| Braddock Rd/Kenwood St           | 271              | 405  | 668  | 811  | 283          | 242   | 799  | 831  |
| Quaker Ln/Seminary Rd/Janney St  | 1019             | 976  | 813  | 584  | 959          | 969   | 675  | 789  |
| Quaker Ln/Duke St                | 0                | 715  | 1551 | 2324 | 1148         | 0     | 1850 | 1592 |
| Taylor/Service Rd                | 178              | 371  | 236  | 121  | 161          | 228   | 384  | 133  |

**Table A-12: 2020 No Build Conditions Link Volumes – Saturday Peak Hour**

| Intersection Location            | Approach Volumes |     |      |      | Exit Volumes |       |      |      |
|----------------------------------|------------------|-----|------|------|--------------|-------|------|------|
|                                  | NB               | SB  | EB   | WB   | North        | South | East | West |
| King St/Taylor St                | 241              | 103 | 1118 | 1273 | 136          | 570   | 985  | 1044 |
| King St/Quaker Ln                | 775              | 779 | 1231 | 865  | 908          | 679   | 790  | 1273 |
| King St (e-w) / Braddock Rd n/s) | 388              | 672 | 790  | 551  | 589          | 358   | 589  | 865  |
| King St/Kenwood St               | 0                | 194 | 796  | 648  | 132          | 0     | 957  | 549  |
| Braddock Rd/Marlee Way           | 0                | 188 | 558  | 496  | 152          | 0     | 598  | 492  |
| Braddock Rd/Quaker Ln            | 865              | 726 | 544  | 358  | 775          | 875   | 388  | 455  |
| Braddock Rd/Kenwood St           | 192              | 300 | 599  | 644  | 205          | 151   | 707  | 672  |
| Quaker Ln/Seminary Rd/Janney St  | 885              | 819 | 502  | 270  | 809          | 887   | 365  | 415  |
| Quaker Ln/Duke St                | 0                | 862 | 1505 | 1807 | 853          | 0     | 2008 | 1313 |

## **Appendix 2: Community Concerns and Suggested Solutions**

## **Appendix 2: Community Concerns and Suggested Solutions**

A summary of written community concerns and suggested solutions to problems in the study area which were submitted by citizens during the first Public Information Meeting held at Minnie Howard Middle School on June 2, 2008 is provided below:

1. Traffic Enforcement and Safety
  - King Street traffic often runs red lights, thereby putting side street traffic at Taylor Street and Wakefield Street accessing King Street at risk. Recommend improved traffic enforcement.
  - Westbound King Street traffic speeds are too high. Recommend lowering speed limit (2 respondents).
  - More police presence is needed.
2. Geometric Changes
  - Adjust roadway height of side streets (Taylor Street and Wakefield Street).
  - Do not raise/lower road way or crosswalks.
  - Consider roundabout at the intersection of King Street/Braddock Road/Quaker Lane. See respondent's sketch (2 respondents).
3. Way Findings
  - Better signage for side street traffic accessing King Street.
  - Lane painted or signage at Quaker Lane and Braddock Road.
  - Better pavement markings.
  - Bigger green guide signage.
4. Improvement of Pedestrian Access
  - Longer crosswalk times for pedestrians crossing King Street from Taylor Street to Bradlee Shopping Center (four respondents).
  - Add pedestrian walkway.
5. Service Road Operational Issues
  - Traffic from Taylor Street turning left onto service road has difficulty with traffic coming out of Bradlee Shopping Center. The right-of-way is not clear. Recommend lane markings.
  - Get rid of the service road (8 respondents).
  - No left turns allowed from service road onto King Street at Bradlee main entrance (2 respondents).
  - Eliminate the brick pillar at Bradlee Shopping Center for better visual at entrance.
  - Stop signs are not obeyed. Recommend control by traffic signals, not flashing lights (2 respondents).
  - Simplify the traffic patterns in and out of Bradlee Shopping Center.
6. Transit Improvement
  - Ask WMATA to extend bus operating hours at night.

- Transit on service road adds to congestion.
  - Do not use the “Shirlington Bus Station” as a good example (for development of a transit stop at Bradlee Shopping Center).
7. Overall Operational Issues
- Synchronize traffic signals (2 respondents).
  - Shorten westbound King Street green at King Street and Wakefield Street intersection.
  - Braddock Road eastbound traffic from Bradlee Shopping Center to Old Town has significant delay during the evening rush hour.
  - The King Street eastbound traffic bound for Bradlee Shopping Center makes a right turn at the King Street/Dearing Street/Wakefield Street (KDW) intersection instead of the slip ramp to the Service Road or the Taylor Street/King Street/Service Road intersection. Recommended more signage to discourage traffic from using the KDW intersection.
8. General Issues and Comments
- Extend study area to include intersections Wakefield Street/Dearing Street/King Street and Taylor Street/King Street (two respondents).
  - Trim brush plants along King Street and Wakefield Street.
  - N. Quaker Lane access needs to be revisited from N. Quaker Lane to I-395 because of over speeding traffic thereby making access difficult (access into/out of 36<sup>th</sup> Street).
  - Address Shirlington Circle access to Quaker Lane Issues.
  - Look at overall traffic management between I-395 and Quaker Lane/Braddock Road/King Street.

In addition, some of the issues identified and discussed with citizens during the first Public Information Meeting are summarized below. During this meeting, twenty-seven citizens signed in.

1. Improvements should be pedestrian friendly.
  - Keep urban/pedestrian concept in mind – pedestrians need to have a safe way to cross.
  - King Street / Wakefield Street pedestrian crossing time is too short to cross.
2. Bus transit service is good now, there does not seem to be a need for improvements or a new transit transfer station.
3. Encourage Developer to reconfigure the Bradlee Shopping Center.
  - More direct ins & outs to improve circulation.
4. Signal at Duke/Quaker – some citizens felt that the current location of the signal head controlling the WB Duke to NB Quaker movement is not located in a desired place. Due to vegetation and the retaining wall, drivers do not see the signal heads until they are right at the crosswalk. Perhaps consider relocating the signal heads so that drivers would be able to see it sooner.
5. NB Quaker backs up due to the left turns to both Braddock and King Street.
  - Some drivers think that the left turn lane at Braddock is also the left turn lane for King. Need better signage to indicate that the first turn bay is for Braddock only.

- Consider restriping the turn bay for Braddock to better indicate that this is for Braddock only.
  - One lane left turn to I-395 and restricted right lane.
6. Consider adding a left turn lane at the NB Kenwood approach to Braddock.
7. Issue with the signal at TC Williams – may need to consider retiming the signal.
- Some citizens complained that when the signal allows time for buses to exit the school, the length is too long – should be shortened, but more frequent.
  - It runs on cycles timed for school hours 24-7, which is not needed in the middle of the night or on weekends. The City explained that sufficient time is needed to allow for pedestrian crossings.
8. Consider the City’s Transportation Management Plan for transit corridors – one citizen felt that Quaker could become one of the N-S routes – consider bus lanes.
9. Improve signage for EB King Street at Quaker to better indicate choices.
- Consider placing the house number hundred on street signs.
  - Signage - “OLD TOWN NEXT LEFT” smaller overhead signs, with arrows.
  - Backlighting on King Street sign.
  - No signs at Bradlee Shopping Center. Street signs need to be added.
10. For SB Quaker at King, the through lanes often queue in the evening, but the right turn lane is free-flow.
- This can cause problems for NB Quaker left turns into Fairlington, (onto 36<sup>th</sup> Street) as the SB through traffic will not block the box, so NB lefts think it is okay, and drivers run risk of being hit by the SB rights.
11. Vegetation overgrowth is an issue – blocks the view of the approaches:
- 36<sup>th</sup> Street
  - Wakefield Street
  - Taylor Street
  - Vegetation also blocks the guide signs, such as the sign for WB King to take Kenwood to reach Braddock.
12. In the PM, WB Braddock backs up due to the low amount of green time available for the WB movement, queue often extends back to Kenwood; same issue for EB Braddock, backs up to Marlee Way.
13. Overall, need to improve signal timings.
- Certain legs of the BKQ intersection do not get adequate timings.
  - SB lefts at Dearing/Wakefield.
  - Re-examine the pedestrian crossing time for all crosswalks crossing King Street.
  - Light at Bradlee Shopping Center – after rainstorm lights reset to short green time. Upgrade equipment.
  - Timing issues – need video feedback upgrade signals to include video detection activation.
  - Pour concrete and change lights.
  - King Street / Wakefield Street pedestrian crossing time too short to cross.
14. For streets coming out of Fairlington, it is uphill/steep incline to get onto King Street – need to adjust the grade of the approach.

15. Need to improve operations on the Service Road.
  - Some felt that certain parts should be closed off so through traffic cannot get through.
  - If closing part of the service road, allow for traffic from Safeway to get to the Bradlee Shopping Center & vice versa.
  - The service road intersection with Dearing needs improvements to address citizens' safety concerns. They feel that traffic speeds through when the drivers see a green light if they are coming from the service road, often not paying attention to the stop signs. One citizen mentioned that her car was recently totaled because a driver on the service road did not yield her the right-of-way.
  - Generally, operations at all service road intersections need to be addressed, including signalization of the service road.
  - Put signals on access road. Signals should be timed with signal at King Street.
  - Get rid of service/access road to widen King Street.
  - Keep service road – it relieves pressure off King Street. (Some citizens would like to keep the service road, others want it removed).
  - Stop signs / cross at green.
  - Intersecting lights – suggestion to use flashing lights to be timed with King Street.
16. King Street needs paving near TC Williams to fix the potholes. More potholes on King Street from I-395 to Quaker Lane intersection.
17. Explore pedestrian bridges to get pedestrians over King Street.
  - Pedestrian walkways over King Street.
    - Under road/over road pedestrian walkways.
    - Many citizens express distain for this idea – homeless/urination problems/create a situation that “criminalized a neighbor pedestrian”.
18. Crashes/Speed
  - Concerns about elevated speeds along Quaker Lane.
  - Concerns about dangerous intersections.
    - Accidents/speeds/fatalities.
    - Severe crashes have occurred in study area. A few of the citizens present were victims of several crashes in the area, and shared their safety concerns.
19. Roundabout concept.
  - Earlier concept of a roundabout.
  - One citizen brought his own RB design to submit for public comment.
20. Quaker Lane.
  - Residents have trouble getting out of 36<sup>th</sup> Street.
    - Backing up/closed intersection.
21. New development, resulting in increased volume.
  - Park Center.
  - Growth in Old Town.

**Appendix 3: King Street/ Dearing Street/ Wakefield Street Safety  
Analysis**

Appendix 3: King Street / Dearing Street / Wakefield Street Safety Analysis

Qualitative Operational and Safety Review – August 2008

At the request of staff from the City of Alexandria, VHB staff familiar with intersection safety and traffic operations provided a qualitative review of the intersection. Of particular interest was the intersection of North Dearing Street with the adjacent frontage service road as shown in **Figure A-1**.

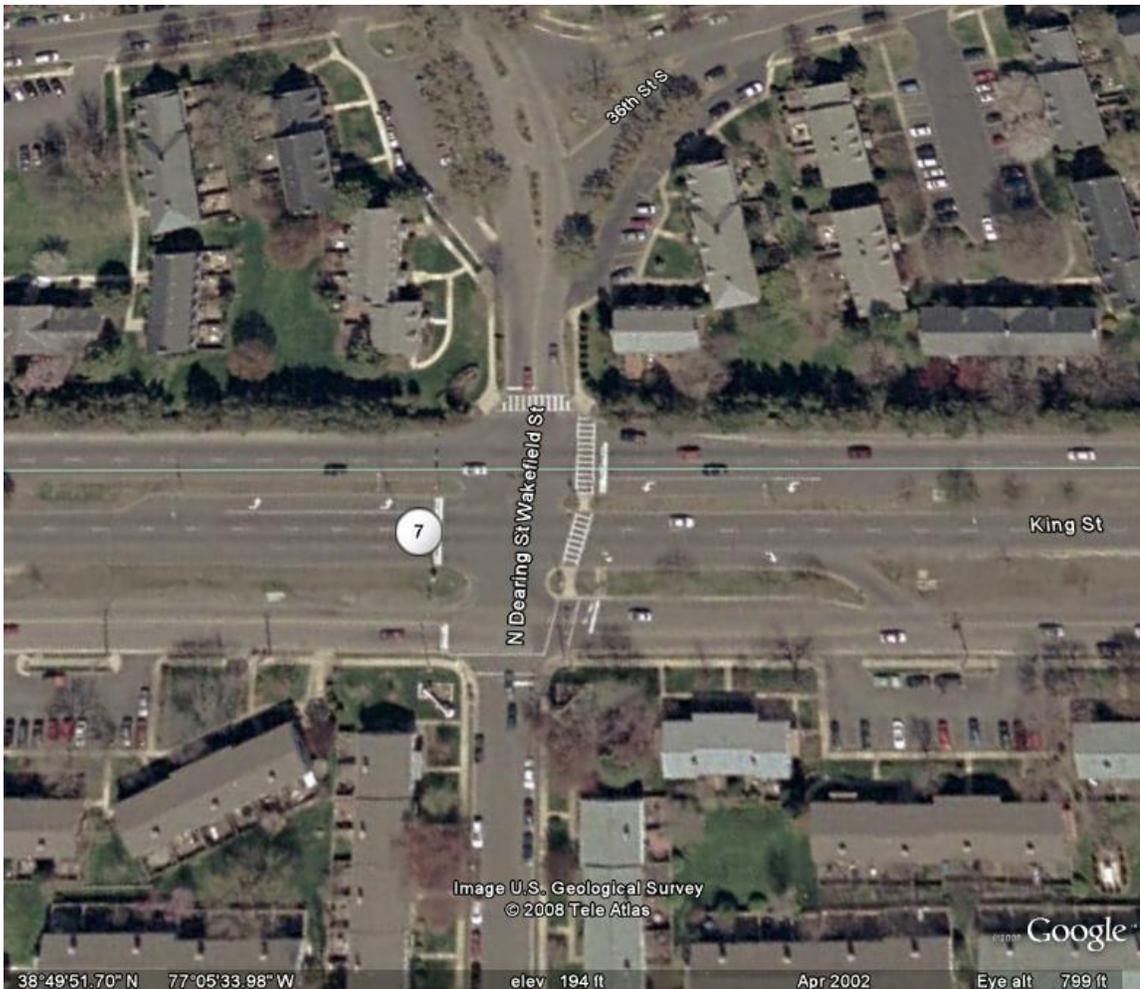


Figure A-1: Study Intersection

Route 7 in this area, is primarily a four (4) lane divided highway generally running east –west. Left turn lanes exist on Route 7. For westbound along Route 7, there is also a right turn lane while the eastbound direction has a third lane that is a through right turn lane that becomes a trapped lane immediately beyond the intersection. This trapped lane terminates into a slip ramp that feeds onto a frontage service road. The service road runs parallel to Route 7 through

the intersection in question.

In general, the intersection has the characteristics or difficulties associated with frontage service roads. By being adjacent to Route 7, the frontage road, at the intersection causes additional conflict opportunities in the intersection. The service road is intended to allow local users to travel the area without entering onto the main roadway. The concept is to reduce vehicles on the main road and promote better access management. However, the lack of adequate separation between the service road and Route 7, essentially places two intersections side by side. The difficulties with this intersection configuration is exacerbated with the high volumes that use this intersection.

The intersection of North Dearing Street with Route 7 is controlled by a traffic signal. The intersection of North Dearing Street and the frontage service road is controlled by a stop sign. What was most apparent at the intersection with the frontage road were the additional features that were previously installed to enhance driver awareness and promote safety. Specifically, in addition to the existing stop sign, there are flashing red traffic signals and an additional cautionary sign that reads “SERVICE ROAD MUST YIELD TO DEARING STREET”. These existing safety enhancements are shown in **Figure A-2**.



Figure A-2: Existing Safety Enhancements

The flashing signal and the supplemental warning suggest that additional concern has been given to this specific intersection. From the crash information (illustrated in **Figure A-3**) and general observations, it appears that drivers are aware of the potential conflicts and react accordingly.

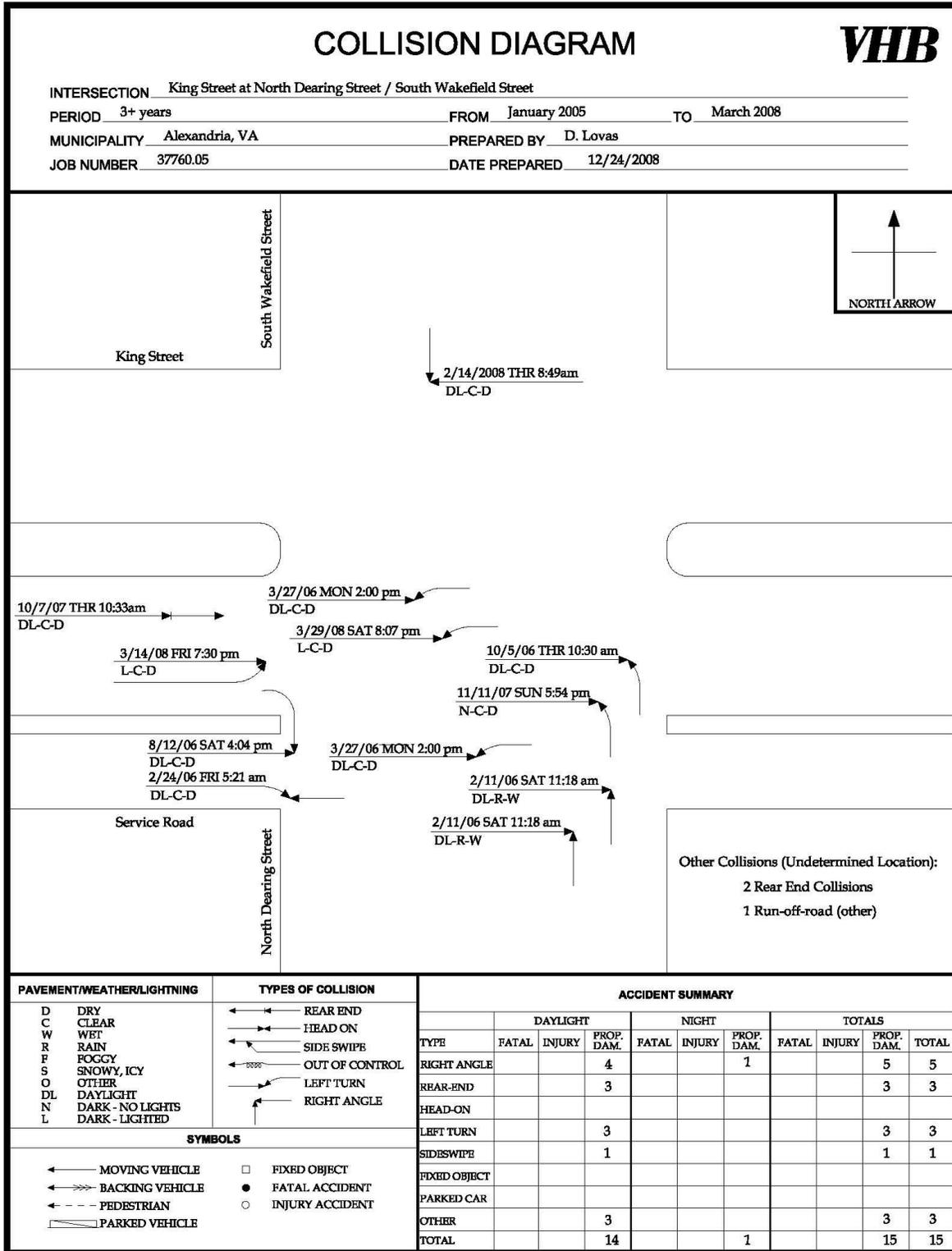
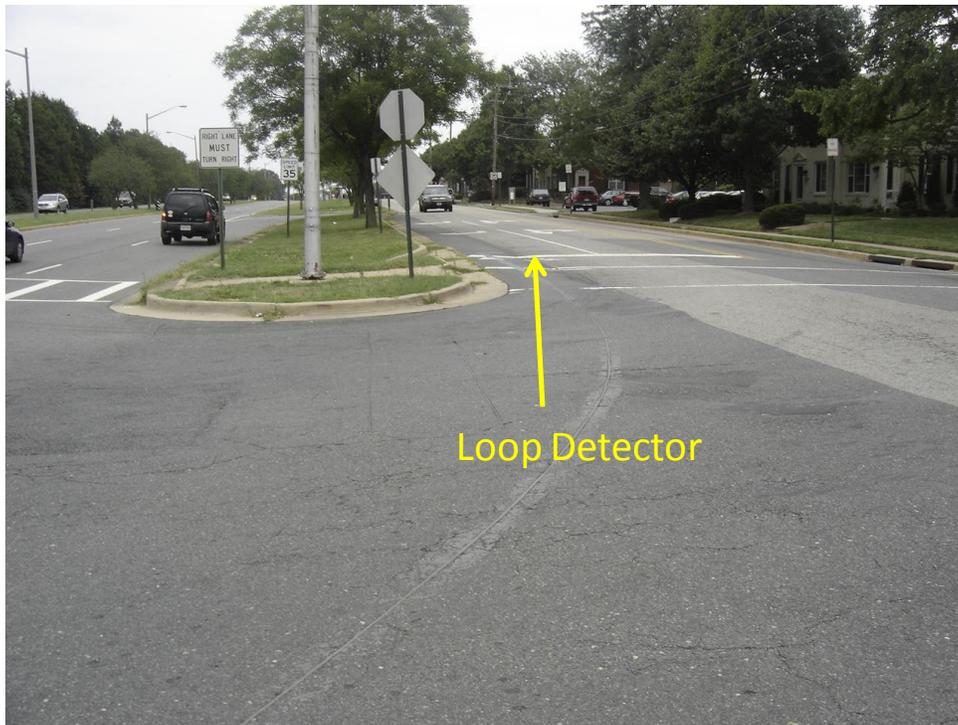


Figure A-3: Collision Diagram

It was observed that there were loop detectors on the service road embedded in the pavement for the traffic signal controlling Route 7 and North Dearing Street. The loops are located properly at the stop bars. For the westbound direction, the stop bar is behind the crosswalk. Consequently, the loop located behind the stop bar is a further back from the intersection and is not in the proximity of the stop sign as shown in **Figure A-4**. If a single car was at this location as shown in **Figure A-5**, it is a high probability that the vehicle would not be detected and the signal controller would not provide the phase for the service road. A recommendation to relocate the stop sign will come from this observation. If drivers stop at the stop sign, it will place the vehicle on the loop and will improve the sight line for the through movement by keeping the right turning vehicle back out of the line of sight.



**Figure A-4: View of Location of Loop Detector**



Figure A-5: View of Vehicle Past the Loop Detector

It was also observed that the Double yellow lines do not align as shown in **Figure A-6**. While this does not appear to be a problem for the drivers, it would be a good practice to have opposing traffic not be in the direct path or have the jog through the intersection as the vehicle travels through. Also, aligning the double yellow lines will push the east bound cars on the service road, closer to the curb. This will provide more room to accommodate the turning radius of larger vehicles such as buses as shown in **Figure A-7** and **Figure A-8**. This too will be a recommendation.



Figure A-6: View of Offset Travelway



Figure A-7: View of Bus Crossing Centerline



Figure A-8: View of Bus Crossing Centerline

**Appendix 4: Preliminary Cost Estimates- Order of Magnitude for  
Potential Improvements**

Appendix 4: Preliminary Cost Estimates - Order of Magnitude for Potential Improvements

Table A-13: Cost Estimate – Conceptual Alternative 1

| King Street / Quaker Lane intersection |                                                                                                                 | Unit      | Unit Cost   | Quantity          | Cost              |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------|-----------|-------------|-------------------|-------------------|
| <b>West Leg</b>                        | <b>widen roadway to place a new through lane (includes restriping) for Eastbound</b>                            |           |             |                   |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y.      | \$6.75      | 207               | \$ 1,397          |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y.      | \$12.47     | 90                | \$ 1,122          |
|                                        | Pavement                                                                                                        |           |             |                   |                   |
|                                        | - Surface (2")                                                                                                  | S.Y.      | \$6.93      | 207               | \$ 1,435          |
|                                        | - Base (6")                                                                                                     | S.Y.      | \$15.50     | 207               | \$ 3,209          |
|                                        | - Sub-base (8")                                                                                                 | S.Y.      | \$10.80     | 207               | \$ 2,236          |
|                                        | Curb & Gutter                                                                                                   | L.F.      | \$11.10     | 300               | \$ 3,330          |
|                                        | Restriping Cost                                                                                                 |           |             |                   |                   |
|                                        | - Lane (Type B CL VI 6")                                                                                        | L.F.      | \$3.64      | 1060              | \$ 3,858          |
|                                        | - Stop Bar (Type B CL VI 24")                                                                                   | L.F.      | \$3.86      | 10                | \$ 39             |
|                                        | - Arrow (single)                                                                                                | EA        | \$83        | 3                 | \$248             |
|                                        | <b>reconfigure service road</b>                                                                                 |           |             |                   |                   |
|                                        | assume Concrete Islands/ Raised medians (8" Cement Concrete Pavement) to reflect closure                        | S.Y.      | \$37.50     | 216               | \$ 8,100          |
|                                        | Curb & Gutter                                                                                                   | L.F.      | \$11.10     | 149               | \$ 1,654          |
| <b>South Leg</b>                       | <b>add additional northbound left turn lane by demolishing portions of the median island and shifting lanes</b> |           |             |                   |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y.      | \$6.75      | 95                | \$ 641            |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y.      | \$12.47     | 43                | \$ 536            |
|                                        | Pavement                                                                                                        |           |             |                   |                   |
|                                        | - Surface (2")                                                                                                  | S.Y.      | \$6.93      | 95                | \$ 658            |
|                                        | - Base (6")                                                                                                     | S.Y.      | \$15.50     | 95                | \$ 1,473          |
|                                        | - Sub-base (8")                                                                                                 | S.Y.      | \$10.80     | 95                | \$ 1,026          |
|                                        | Curb & Gutter                                                                                                   | L.F.      | \$11.10     | 70                | \$ 777            |
|                                        | Restriping Cost                                                                                                 |           |             |                   |                   |
|                                        | - Lane (Type B CL VI 6")                                                                                        | L.F.      | \$3.64      | 291               | \$ 1,059          |
|                                        | - Stop Bar (Type B CL VI 24") - including departure lane                                                        | L.F.      | \$3.86      | 55                | \$ 212            |
|                                        | - Arrow (single) - including departure lane                                                                     | EA        | \$83        | 8                 | \$662             |
|                                        | <b>reshape of the island to right to include through lane</b>                                                   |           |             |                   |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y.      | \$6.75      | 235               | \$ 1,586          |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y.      | \$12.47     | 104               | \$ 1,297          |
| Pavement                               |                                                                                                                 |           |             |                   |                   |
| - Surface (2")                         | S.Y.                                                                                                            | \$6.93    | 235         | \$ 1,629          |                   |
| - Base (6")                            | S.Y.                                                                                                            | \$15.50   | 235         | \$ 3,643          |                   |
| - Sub-base (8")                        | S.Y.                                                                                                            | \$10.80   | 235         | \$ 2,538          |                   |
| Curb & Gutter                          | L.F.                                                                                                            | \$11.10   | 167         | \$ 1,854          |                   |
| <b>East Leg</b>                        | <b>reshape of the median island</b>                                                                             |           |             |                   |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y.      | \$6.75      | 53                | \$ 358            |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y.      | \$12.47     | 24                | \$ 299            |
|                                        | Pavement                                                                                                        |           |             |                   |                   |
|                                        | - Surface (2")                                                                                                  | S.Y.      | \$6.93      | 53                | \$ 367            |
|                                        | - Base (6")                                                                                                     | S.Y.      | \$15.50     | 53                | \$ 822            |
|                                        | - Sub-base (8")                                                                                                 | S.Y.      | \$10.80     | 53                | \$ 572            |
|                                        | Curb & Gutter                                                                                                   | L.F.      | \$11.10     | 182               | \$ 2,020          |
|                                        | Restriping Cost                                                                                                 |           |             |                   |                   |
|                                        | - Lane (Type B CL VI 6") - including departure lane                                                             | L.F.      | \$3.64      | 590               | \$ 2,148          |
|                                        | - Stop Bar (Type B CL VI 24") - including departure lane                                                        | L.F.      | \$3.86      | 44                | \$ 170            |
|                                        | - Arrow (single) - including departure lane                                                                     | EA        | \$83        | 8                 | \$662             |
|                                        | <b>New Signal</b>                                                                                               | EA        | \$250,000   | 1                 | \$250,000         |
|                                        | <b>Cost</b>                                                                                                     |           |             |                   | <b>\$ 303,636</b> |
|                                        | <b>Braddock Road / Quaker Lane</b>                                                                              |           | <b>Unit</b> | <b>Unit Cost</b>  | <b>Quantity</b>   |
| <b>East Leg</b>                        | <b>include additional left turn lane and through lane (includes restriping)</b>                                 |           |             |                   |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y.      | \$6.75      | 27                | \$ 182            |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y.      | \$12.47     | 12                | \$ 150            |
|                                        | Pavement                                                                                                        |           |             |                   |                   |
|                                        | - Surface (2")                                                                                                  | S.Y.      | \$6.93      | 27                | \$ 187            |
|                                        | - Base (6")                                                                                                     | S.Y.      | \$15.50     | 27                | \$ 419            |
|                                        | - Sub-base (8")                                                                                                 | S.Y.      | \$10.80     | 27                | \$ 292            |
|                                        | Restriping Cost                                                                                                 |           |             |                   |                   |
|                                        | - Lane (Type B CL VI 6")                                                                                        | L.F.      | \$3.64      | 485               | \$ 1,765          |
|                                        | - Stop Bar (Type B CL VI 24")                                                                                   | L.F.      | \$3.86      | 44                | \$ 170            |
| - Arrow (single)                       | EA                                                                                                              | \$83      | 4           | \$331             |                   |
| <b>New Signal</b>                      | EA                                                                                                              | \$250,000 | 1           | \$250,000         |                   |
| <b>Cost</b>                            |                                                                                                                 |           |             | <b>\$ 253,495</b> |                   |

**Table A-13: Cost Estimate – Conceptual Alternative 1(Continued)**

| Braddock Road / King Street |                                                                                                                     | Unit | Unit Cost | Quantity | Cost                |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------|------|-----------|----------|---------------------|
| <b>East Leg</b>             | <b>reconfigure the receiving lane and the sidewalk</b>                                                              |      |           |          |                     |
| <b>(Receiving Leg)</b>      | <b>Add a new through lane (includes restriping)</b>                                                                 |      |           |          |                     |
|                             | Demolish portions of existing sidewalk after ROW take (Demolish, Remove Pavement and Curve - assume 4" to 6" thick) | S.Y. | \$6.75    | 125      | \$ 844              |
|                             | - Earthwork (Site prep, Excavation etc.)                                                                            | C.Y. | \$12.47   | 56       | \$ 698              |
|                             | Pavement                                                                                                            |      |           |          |                     |
|                             | - Surface (2")                                                                                                      | S.Y. | \$6.93    | 125      | \$ 866              |
|                             | - Base (6")                                                                                                         | S.Y. | \$15.50   | 125      | \$ 1,938            |
|                             | - Sub-base (8")                                                                                                     | S.Y. | \$10.80   | 125      | \$ 1,350            |
|                             | Curb & Gutter                                                                                                       | L.F. | \$11.10   | 178      | \$ 1,976            |
|                             | Restriping Cost                                                                                                     |      |           |          |                     |
|                             | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 70       | \$ 255              |
|                             | - Stop Bar (Type B CL VI 24")                                                                                       | L.F. | \$3.86    | 0        | \$ -                |
|                             | - Arrow (single)                                                                                                    | EA   | \$83      | 0        | \$ 0                |
|                             | <b>Add a new sidewalk</b>                                                                                           | S.Y. | \$7.55    | 106      | \$ 800              |
| <b>East Leg</b>             | <b>restripe to include two through and a right turn lane</b>                                                        |      |           |          |                     |
| <b>(Westbound)</b>          | Demolish portions of existing sidewalk after ROW take (Demolish, Remove Pavement and Curve - assume 4" to 6" thick) | S.Y. | \$6.75    | 308      | \$ 2,079            |
|                             | - Earthwork (Site prep, Excavation etc.)                                                                            | C.Y. | \$12.47   | 137      | \$ 1,708            |
|                             | Pavement                                                                                                            |      |           |          |                     |
|                             | - Surface (2")                                                                                                      | S.Y. | \$6.93    | 308      | \$ 2,134            |
|                             | - Base (6")                                                                                                         | S.Y. | \$15.50   | 308      | \$ 4,774            |
|                             | - Sub-base (8")                                                                                                     | S.Y. | \$10.80   | 308      | \$ 3,326            |
|                             | Curb & Gutter                                                                                                       | L.F. | \$11.10   | 318      | \$ 3,530            |
|                             | Restriping Cost                                                                                                     |      |           |          |                     |
|                             | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 1262     | \$ 4,594            |
|                             | - Stop Bar (Type B CL VI 24")                                                                                       | L.F. | \$3.86    | 33       | \$ 127              |
|                             | - Arrow (single)                                                                                                    | EA   | \$83      | 3        | \$ 248              |
|                             | <b>Add a new sidewalk</b>                                                                                           | S.Y. | \$7.55    | 210      | \$ 1,586            |
| <b>Northwest Leg</b>        | <b>reshape of the island to south to include southeastbound dual left and two through lanes (already accounted)</b> |      |           |          |                     |
| <b>Southeast Leg</b>        | <b>reconfigure the departure (receiving) lane and the sidewalk</b>                                                  |      |           |          |                     |
| <b>(Receiving Leg)</b>      | Demolish portions of existing sidewalk after ROW take (assume 4" to 6" thick)                                       | S.Y. | \$6.75    | 37       | \$ 250              |
|                             | - Earthwork (Site prep, Excavation etc.)                                                                            | C.Y. | \$12.47   | 17       | \$ 212              |
|                             | Pavement                                                                                                            |      |           |          |                     |
|                             | - Surface (2")                                                                                                      | S.Y. | \$6.93    | 37       | \$ 256              |
|                             | - Base (6")                                                                                                         | S.Y. | \$15.50   | 37       | \$ 574              |
|                             | - Sub-base (8")                                                                                                     | S.Y. | \$10.80   | 37       | \$ 400              |
|                             | Curb & Gutter                                                                                                       | L.F. | \$11.10   | 72       | \$ 799              |
|                             | Restriping Cost                                                                                                     |      |           |          |                     |
|                             | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 30       | \$ 109              |
|                             | <b>Add a new sidewalk</b>                                                                                           | S.Y. | \$7.55    | 50       | \$ 378              |
| <b>Southeast Leg</b>        | Restriping Cost                                                                                                     |      |           |          |                     |
| <b>(northwest bound)</b>    | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 320      | \$ 1,165            |
|                             | - Stop Bar (Type B CL VI 24")                                                                                       | L.F. | \$3.86    | 22       | \$ 85               |
|                             | - Arrow (single)                                                                                                    | EA   | \$83      | 2        | \$165               |
| <b>New Signal</b>           |                                                                                                                     | EA   | \$250,000 | 1        | \$250,000           |
|                             | <b>Improvement Cost</b>                                                                                             |      |           |          | <b>\$ 287,226</b>   |
|                             | <b>Conceptual Alternative 1 Total Improvement Cost</b>                                                              |      |           |          | <b>\$ 844,357</b>   |
|                             | <b>Preliminary Engineering Cost (30% of the Total Improvement Cost)</b>                                             |      |           |          | <b>\$ 253,307</b>   |
|                             | <b>Construction Contingency (20% of the Total Improvement Cost)</b>                                                 |      |           |          | <b>\$ 168,871</b>   |
|                             | <b>ROW Cost (75% of the Total Improvement Cost)</b>                                                                 |      |           |          | <b>\$ 633,267</b>   |
|                             | <b>Total</b>                                                                                                        |      |           |          | <b>\$ 1,899,802</b> |

Table A-14: Cost Estimate – Conceptual Alternative 2

| King Street / Quaker Lane intersection |                                                                                                                 | Unit | Unit Cost | Quantity | Cost              |
|----------------------------------------|-----------------------------------------------------------------------------------------------------------------|------|-----------|----------|-------------------|
| <b>West Leg</b>                        | <b>widen roadway to place a new through lane (includes restriping) for Eastbound</b>                            |      |           |          |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y. | \$6.75    | 207      | \$ 1,397          |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y. | \$12.47   | 90       | \$ 1,122          |
|                                        | Pavement                                                                                                        |      |           |          |                   |
|                                        | - Surface (2")                                                                                                  | S.Y. | \$6.93    | 207      | \$ 1,435          |
|                                        | - Base (6")                                                                                                     | S.Y. | \$15.50   | 207      | \$ 3,209          |
|                                        | - Sub-base (8")                                                                                                 | S.Y. | \$10.80   | 207      | \$ 2,236          |
|                                        | Curb & Gutter                                                                                                   | L.F. | \$11.10   | 300      | \$ 3,330          |
|                                        | Restriping Cost                                                                                                 |      |           |          |                   |
|                                        | - Lane (Type B CL VI 6")                                                                                        | L.F. | \$3.64    | 1060     | \$ 3,858          |
|                                        | - Stop Bar (Type B CL VI 24")                                                                                   | L.F. | \$3.86    | 10       | \$ 39             |
|                                        | - Arrow (single)                                                                                                | EA   | \$83      | 3        | \$248             |
|                                        | <b>reconfigure service road</b>                                                                                 |      |           |          |                   |
|                                        | assume Concrete Islands/ Raised medians (8" Cement Concrete Pavement) to reflect closure                        | S.Y. | \$37.50   | 216      | \$ 8,100          |
|                                        | Curb & Gutter                                                                                                   | L.F. | \$11.10   | 149      | \$ 1,654          |
| <b>South Leg</b>                       | <b>add additional northbound left turn lane by demolishing portions of the median island and shifting lanes</b> |      |           |          |                   |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y. | \$6.75    | 76       | \$ 513            |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y. | \$12.47   | 34       | \$ 424            |
|                                        | Pavement                                                                                                        |      |           |          |                   |
|                                        | - Surface (2")                                                                                                  | S.Y. | \$6.93    | 76       | \$ 527            |
|                                        | - Base (6")                                                                                                     | S.Y. | \$15.50   | 76       | \$ 1,178          |
|                                        | - Sub-base (8")                                                                                                 | S.Y. | \$10.80   | 76       | \$ 821            |
|                                        | Curb & Gutter                                                                                                   | L.F. | \$11.10   | 108      | \$ 1,199          |
|                                        | Restriping Cost                                                                                                 |      |           |          |                   |
|                                        | - Lane (Type B CL VI 6")                                                                                        | L.F. | \$3.64    | 390      | \$ 1,420          |
|                                        | - Stop Bar (Type B CL VI 24") - including departure lane                                                        | L.F. | \$3.86    | 88       | \$ 340            |
|                                        | - Arrow (single) - including departure lane                                                                     | EA   | \$83      | 10       | \$827             |
|                                        | - Arrow (double)                                                                                                | EA   | \$137     | 1        | \$137             |
|                                        | <b>reshape of the island to right to include northbound through plus right and exclusive right lanes</b>        |      |           |          |                   |
|                                        | assume Concrete Islands/ Raised medians (8" Cement Concrete Pavement) to reflect closure                        | S.Y. | \$37.50   | 667      | \$ 25,013         |
|                                        | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)       | S.Y. | \$6.75    | 231      | \$ 1,559          |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y. | \$12.47   | 103      | \$ 1,284          |
|                                        | Pavement                                                                                                        |      |           |          |                   |
|                                        | - Surface (2")                                                                                                  | S.Y. | \$6.93    | 231      | \$ 1,601          |
|                                        | - Base (6")                                                                                                     | S.Y. | \$15.50   | 231      | \$ 3,581          |
|                                        | - Sub-base (8")                                                                                                 | S.Y. | \$10.80   | 231      | \$ 2,495          |
|                                        | Curb & Gutter                                                                                                   | L.F. | \$11.10   | 266      | \$ 2,953          |
| <b>East Leg</b>                        | <b>Add dual left turn lanes and shift two through lanes, including Eliminate the median island</b>              |      |           |          |                   |
|                                        | Demolish portions of existing sidewalk after ROW take (assume 4" to 6" thick)                                   | S.Y. | \$6.75    | 279      | \$ 1,883          |
|                                        | - Earthwork (Site prep, Excavation etc.)                                                                        | C.Y. | \$12.47   | 124      | \$ 1,546          |
|                                        | Pavement                                                                                                        |      |           |          |                   |
|                                        | - Surface (2")                                                                                                  | S.Y. | \$6.93    | 279      | \$ 1,933          |
|                                        | - Base (6")                                                                                                     | S.Y. | \$15.50   | 279      | \$ 4,325          |
|                                        | - Sub-base (8")                                                                                                 | S.Y. | \$10.80   | 279      | \$ 3,013          |
|                                        | Curb & Gutter                                                                                                   | L.F. | \$11.10   | 142      | \$ 1,576          |
|                                        | Restriping Cost                                                                                                 |      |           |          |                   |
|                                        | - Lane (Type B CL VI 6") - including departure lane                                                             | L.F. | \$3.64    | 885      | \$ 3,221          |
|                                        | - Stop Bar (Type B CL VI 24") - including departure lane                                                        | L.F. | \$3.86    | 88       | \$ 340            |
|                                        | - Arrow (single) - including departure lane                                                                     | EA   | \$83      | 16       | \$1,324           |
|                                        | Add a new sidewalk                                                                                              | S.Y. | \$7.55    | 117      | \$ 883            |
| New Signal                             |                                                                                                                 | EA   | \$250,000 | 1        | \$250,000         |
|                                        | <b>Improvement Cost</b>                                                                                         |      |           |          | <b>\$ 342,542</b> |
| <b>Braddock Road / Quaker Lane</b>     |                                                                                                                 |      |           |          |                   |
| <b>West Leg</b>                        | <b>reconfigure to close through movement maneuver and restripe to include dual left</b>                         |      |           |          |                   |
|                                        | assume Concrete Islands/ Raised medians (8" Cement Concrete Pavement) to reflect closure                        | S.Y. | \$37.50   | 91       | \$ 3,413          |
|                                        | Curb & Gutter                                                                                                   | L.F. | \$11.10   | 125      | \$ 1,388          |
|                                        | Restriping Cost                                                                                                 |      |           |          |                   |
|                                        | - Arrow (single) - including departure lane                                                                     | EA   | \$83      | 4        | \$331             |
| <b>East Leg</b>                        | reshape of the median island to close off the west leg of the intersection (already reflected)                  |      |           |          |                   |
| <b>New Signal</b>                      |                                                                                                                 | EA   | \$250,000 | 1        | \$250,000         |
|                                        | <b>Cost</b>                                                                                                     |      |           |          | <b>\$ 255,131</b> |

**Table A-14: Cost Estimate – Conceptual Alternative 2 (Continued)**

| Braddock Road / King Street |                                                                                                                     | Unit | Unit Cost | Quantity | Cost                |
|-----------------------------|---------------------------------------------------------------------------------------------------------------------|------|-----------|----------|---------------------|
| <b>East Leg</b>             | <b>reconfigure the departure (receiving) lane and the sidewalk</b>                                                  |      |           |          |                     |
| <b>(Receiving Leg)</b>      | <b>Add a new through lane (includes restriping)</b>                                                                 |      |           |          |                     |
|                             | Demolish portions of existing sidewalk after ROW take (Demolish, Remove Pavement and Curve - assume 4" to 6" thick) | S.Y. | \$6.75    | 116      | \$ 783              |
|                             | - Earthwork (Site prep, Excavation etc.)                                                                            | C.Y. | \$12.47   | 52       | \$ 648              |
|                             | Pavement                                                                                                            |      |           |          |                     |
|                             | - Surface (2")                                                                                                      | S.Y. | \$6.93    | 116      | \$ 804              |
|                             | - Base (6")                                                                                                         | S.Y. | \$15.50   | 116      | \$ 1,798            |
|                             | - Sub-base (8")                                                                                                     | S.Y. | \$10.80   | 116      | \$ 1,253            |
|                             | Curb & Gutter                                                                                                       | L.F. | \$11.10   | 177      | \$ 1,965            |
|                             | Restriping Cost                                                                                                     |      |           |          |                     |
|                             | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 205      | \$ 746              |
|                             | - Stop Bar (Type B CL VI 24")                                                                                       | L.F. | \$3.86    | 0        | \$ -                |
|                             | - Arrow (single)                                                                                                    | EA   | \$83      | 0        | \$ 0                |
|                             | <b>Add a new sidewalk</b>                                                                                           | S.Y. | \$7.55    | 108      | \$ 815              |
| <b>East Leg</b>             | Restriping Cost                                                                                                     |      |           |          |                     |
| <b>(Westbound)</b>          | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 20       | \$ 73               |
|                             | - Stop Bar (Type B CL VI 24")                                                                                       | L.F. | \$3.86    | 33       | \$ 127              |
|                             | - Arrow (single)                                                                                                    | EA   | \$83      | 2        | \$165               |
| <b>Southeast Leg</b>        | Restriping Cost                                                                                                     |      |           |          |                     |
| <b>(Northwestbound)</b>     | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 200      | \$ 728              |
|                             | - Stop Bar (Type B CL VI 24")                                                                                       | L.F. | \$3.86    | 22       | \$ 85               |
|                             | - Arrow (single)                                                                                                    | EA   | \$83      | 2        | \$165               |
| <b>Southeast Leg</b>        | <b>reconfigure the departure (receiving) lane and the sidewalk</b>                                                  |      |           |          |                     |
| <b>(Receiving Leg)</b>      | Demolish portions of existing sidewalk after ROW take (assume 4" to 6" thick)                                       | S.Y. | \$6.75    | 18       | \$ 122              |
|                             | - Earthwork (Site prep, Excavation etc.)                                                                            | C.Y. | \$12.47   | 8        | \$ 100              |
|                             | Pavement                                                                                                            |      |           |          |                     |
|                             | - Surface (2")                                                                                                      | S.Y. | \$6.93    | 18       | \$ 125              |
|                             | - Base (6")                                                                                                         | S.Y. | \$15.50   | 18       | \$ 279              |
|                             | - Sub-base (8")                                                                                                     | S.Y. | \$10.80   | 18       | \$ 194              |
|                             | Curb & Gutter                                                                                                       | L.F. | \$11.10   | 62       | \$ 688              |
|                             | Restriping Cost                                                                                                     |      |           |          |                     |
|                             | - Lane (Type B CL VI 6")                                                                                            | L.F. | \$3.64    | 35       | \$ 127              |
|                             | <b>Add a new sidewalk</b>                                                                                           | S.Y. | \$7.55    | 26       | \$ 196              |
| <b>New Signal</b>           |                                                                                                                     | EA   | \$250,000 | 1        | \$250,000           |
|                             | <b>Improvement Cost</b>                                                                                             |      |           |          | <b>\$ 261,988</b>   |
|                             | <b>Conceptual Alternative 2 Total Improvement Cost</b>                                                              |      |           |          | <b>\$ 859,660</b>   |
|                             | <b>Preliminary Engineering Cost (30% of the Total Improvement Cost)</b>                                             |      |           |          | <b>\$ 257,898</b>   |
|                             | <b>Construction Contingency (20% of the Total Improvement Cost)</b>                                                 |      |           |          | <b>\$ 171,932</b>   |
|                             | <b>ROW Cost (75% of the Total Improvement Cost)</b>                                                                 |      |           |          | <b>\$ 644,745</b>   |
|                             | <b>Total</b>                                                                                                        |      |           |          | <b>\$ 1,934,236</b> |

Table A-15: Cost Estimate – Service Roads and Transit Improvements at Bradlee Shopping Center

| King Street / Taylor Street intersection |                                                                                                                    | Unit  | Unit Cost | Quantity | Cost              |
|------------------------------------------|--------------------------------------------------------------------------------------------------------------------|-------|-----------|----------|-------------------|
| <b>West Leg</b>                          | <b>close the section of the service road</b>                                                                       |       |           |          |                   |
|                                          | assume Concrete Islands/ Raised medians (8" Cement Concrete Pavement) to reflect closure                           | S.Y.  | \$37.50   | 600      | \$ 22,500         |
|                                          | Curb & Gutter                                                                                                      | L.F.  | \$11.10   | 1062     | \$ 11,788         |
|                                          | <b>adding a bus circulation lane along the existing median (between King Street and Service Road) and restripe</b> |       |           |          |                   |
|                                          | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)          | S.Y.  | \$6.75    | 195      | \$ 1,316          |
|                                          | - Earthwork (Site prep, Excavation etc.)                                                                           | C.Y.  | \$12.47   | 86       |                   |
|                                          | Pavement                                                                                                           |       |           |          |                   |
|                                          | - Surface (2")                                                                                                     | S.Y.  | \$6.93    | 195      | \$ 1,351          |
|                                          | - Base (6")                                                                                                        | S.Y.  | \$15.50   | 195      | \$ 3,023          |
|                                          | - Sub-base (8")                                                                                                    | S.Y.  | \$10.80   | 195      | \$ 2,106          |
|                                          | Curb & Gutter                                                                                                      | L.F.  | \$11.10   | 495      |                   |
|                                          | <b>addition of the new signs</b>                                                                                   |       |           |          |                   |
|                                          | Do Not Enter sign                                                                                                  | S.F.  | \$28.25   | 12.5     | \$ 353            |
|                                          | Buses Only sign                                                                                                    | S.F.  | \$28.25   | 7.5      | \$ 212            |
|                                          | No Right Turn sign                                                                                                 | S.F.  | \$29.25   | 6.25     | \$ 183            |
| Sign Post (steel 12")                    | EA                                                                                                                 | \$690 | 5         | \$3,450  |                   |
| Stripe Arrow (single)                    | EA                                                                                                                 | \$83  | 4         | \$331    |                   |
| <b>East Leg</b>                          | <b>close the section of the service road</b>                                                                       |       |           |          |                   |
|                                          | assume Concrete Islands/ Raised medians (8" Cement Concrete Pavement) to reflect closure                           | S.Y.  | \$37.50   | 362      | \$ 13,575         |
|                                          | Curb & Gutter                                                                                                      | L.F.  | \$11.10   | 380      | \$ 4,218          |
|                                          | <b>adding a turn bay along the existing median and restripe</b>                                                    |       |           |          |                   |
|                                          | Demolish portions of existing median island (Demolish, Remove Pavement and Curve - assume 4" to 6" thick)          | S.Y.  | \$6.75    | 156      | \$ 1,053          |
|                                          | - Earthwork (Site prep, Excavation etc.)                                                                           | C.Y.  | \$12.47   | 70       |                   |
|                                          | Pavement                                                                                                           |       |           |          |                   |
|                                          | - Surface (2")                                                                                                     | S.Y.  | \$6.93    | 156      | \$ 1,081          |
|                                          | - Base (6")                                                                                                        | S.Y.  | \$15.50   | 156      | \$ 2,418          |
|                                          | - Sub-base (8")                                                                                                    | S.Y.  | \$10.80   | 156      | \$ 1,685          |
|                                          | Curb & Gutter                                                                                                      | L.F.  | \$11.10   | 207      | \$ 2,298          |
|                                          | <b>addition of the new signs</b>                                                                                   |       |           |          |                   |
|                                          | Do Not Enter sign                                                                                                  | S.F.  | \$28.25   | 12.5     | \$ 353            |
|                                          | Stop Sign                                                                                                          | S.F.  | \$28.25   | 6.25     | \$ 177            |
|                                          | No Left Turn sign                                                                                                  | S.F.  | \$29.25   | 4        | \$ 117            |
| Sign Post (steel 12")                    | EA                                                                                                                 | \$690 | 2         | \$1,380  |                   |
| Stripe Arrow (single)                    | EA                                                                                                                 | \$83  | 2         | \$165    |                   |
| <b>South Leg</b>                         | <b>restripe of the roadway extending to the intersection with King Street</b>                                      |       |           |          |                   |
|                                          | Restriping Cost                                                                                                    |       |           |          |                   |
|                                          | - Lane (Type B CL VI 6")                                                                                           | L.F.  | \$3.64    | 280      | \$ 1,019          |
|                                          | - Stop Bar (Type B CL VI 24")                                                                                      | L.F.  | \$3.86    | 22       | \$ 85             |
|                                          | - Arrow (single)                                                                                                   | EA    | \$83      | 1        | \$83              |
| - Arrow (double)                         | EA                                                                                                                 | \$137 | 1         | \$137    |                   |
| <b>New Signal</b>                        |                                                                                                                    | EA    | \$250,000 | 1        | \$250,000         |
|                                          | <b>Cost</b>                                                                                                        |       |           |          | <b>\$ 326,456</b> |
|                                          | <b>Preliminary Engineering Cost (30% of the Total Improvement Cost)</b>                                            |       |           |          | <b>\$ 97,937</b>  |
|                                          | <b>Construction Contingency (20% of the Total Improvement Cost)</b>                                                |       |           |          | <b>\$ 65,291</b>  |
|                                          | <b>Total</b>                                                                                                       |       |           |          | <b>\$ 489,684</b> |

Table A-16: Cost Estimate – Short-Term Improvements

| King St / Dearing Street / Wakefield Street |                                                                                                                 | Unit        | Unit Cost        | Quantity        | Cost             |
|---------------------------------------------|-----------------------------------------------------------------------------------------------------------------|-------------|------------------|-----------------|------------------|
| <b>Northwest Leg</b>                        | restripe the service road to better align and allow more room for buses making right turn into the service road |             |                  |                 |                  |
|                                             | Restriping Cost                                                                                                 |             |                  |                 |                  |
|                                             | - Lane (Type B CL VI 6")                                                                                        | L.F.        | \$3.64           | 200             | \$ 728           |
|                                             | - Stop Bar (Type B CL VI 24")                                                                                   | L.F.        | \$3.86           | 22              | \$ 85            |
| <b>Southeast Leg</b>                        | Relocate existing signs on steel signpost further back just before the crosswalk                                | EA          | \$1,440          | 1               | \$1,440          |
|                                             | <b>Cost</b>                                                                                                     |             |                  |                 | <b>\$ 2,253</b>  |
| <b>King St / Braddock Rd / Quaker Ln</b>    |                                                                                                                 | <b>Unit</b> | <b>Unit Cost</b> | <b>Quantity</b> | <b>Cost</b>      |
|                                             | Guide signs                                                                                                     | S.F.        | \$28.25          | 165             | \$ 4,661         |
|                                             | Yield to Pedestrians sign                                                                                       | S.F.        | \$28.25          | 21              | \$ 593           |
|                                             | Left turn sign                                                                                                  | S.F.        | \$28.25          | 9               | \$ 254           |
|                                             | Do Not Block sign                                                                                               | S.F.        | \$28.25          | 5               | \$ 141           |
|                                             | Sign Post (steel 12")                                                                                           | EA          | \$690            | 6               | \$4,140          |
|                                             | Trim vegetation                                                                                                 | EA          | \$10,000.00      | 1               | \$ 10,000        |
|                                             | <b>Cost</b>                                                                                                     |             |                  |                 | <b>\$ 19,790</b> |
|                                             | <b>Costs - all Short Term Improvements</b>                                                                      |             |                  |                 | <b>\$ 22,043</b> |
|                                             | <b>Preliminary Engineering Cost (30% of the Total Improvement Cost)</b>                                         |             |                  |                 | <b>\$ 6,613</b>  |
|                                             | <b>Construction Contingency (20% of the Total Improvement Cost)</b>                                             |             |                  |                 | <b>\$ 4,409</b>  |
|                                             | <b>Total</b>                                                                                                    |             |                  |                 | <b>\$ 33,064</b> |

Table A-17: Cost Estimate –Road Diet Improvements

| Quaker Lane between King St and Duke St                                                                                                                              |                                                                         | Unit | Unit Cost | Quantity | Cost              |
|----------------------------------------------------------------------------------------------------------------------------------------------------------------------|-------------------------------------------------------------------------|------|-----------|----------|-------------------|
| <b>Restripe along Quaker Lane to reconfigure the existing undivided four-lane facility into a two-lane facility with a two-way left turn lane as the center lane</b> |                                                                         |      |           |          |                   |
|                                                                                                                                                                      | Restriping Cost                                                         |      |           |          |                   |
|                                                                                                                                                                      | - Lane (Type B CL VI 6")                                                | L.F. | \$3.64    | 26612    | \$ 96,868         |
| <b>Signal Modification</b>                                                                                                                                           | <b>Loop Cables</b>                                                      |      |           |          |                   |
|                                                                                                                                                                      | 14/1 Enclosed Cond. Cable (6' X 40' loop)                               | L.F. | \$0.62    | 2112     | \$ 1,309          |
|                                                                                                                                                                      | 14/2 Conductor Cable Shielded                                           | L.F. | \$1.12    | 300      | \$ 336            |
|                                                                                                                                                                      | Saw Cut                                                                 |      |           |          |                   |
|                                                                                                                                                                      | 6' X 40' loop                                                           | L.F. | \$5.70    | 850      | \$ 4,843          |
|                                                                                                                                                                      | <b>Cost</b>                                                             |      |           |          | <b>\$ 103,356</b> |
|                                                                                                                                                                      | <b>Preliminary Engineering Cost (30% of the Total Improvement Cost)</b> |      |           |          | <b>\$ 31,007</b>  |
|                                                                                                                                                                      | <b>Construction Contingency (20% of the Total Improvement Cost)</b>     |      |           |          | <b>\$ 20,671</b>  |
|                                                                                                                                                                      | <b>Total</b>                                                            |      |           |          | <b>\$ 155,034</b> |