

Lake Street Corridor Transportation Analysis Report

Arlington Transportation Advisory Committee

December 2014

EXECUTIVE SUMMARY

The Board of Selectmen requested that the Transportation Advisory Committee (TAC) evaluate alternatives to improve mobility and safety along the Lake Street corridor. Issues include:

- Vehicle congestion, delay and queuing on Lake Street, particularly eastbound during the afternoon peak period and westbound during the morning peak period;
- Vehicle congestion, delay and queuing on Brooks Avenue northbound at Hardy School during the morning peak period;
- Safety issues arising from conflicts between pedestrians, bicyclists and motorists at the intersection of Lake Street and the Minuteman Bikeway (Donald R. Marquis Minuteman Trail);
- Poor visibility and lighting of Bikeway viewed from Lake Street; and
- Traffic congestion on Lake Street may exacerbate the number of vehicles attempting to use other streets as cut-through routes.

The TAC formed a working group to identify and evaluate improvement alternatives and hired a professional traffic engineer to perform traffic capacity analysis of the alternatives. Alternatives evaluated included no action, signal timing improvements at the existing signal at Brooks Avenue and Lake Street, and a new signal at the Minuteman Bikeway and Lake Street. Four alternatives for coordinating the Brooks Avenue and potential Bikeway signals were analyzed. Additional alternatives such as roadway widening and grade separation of Lake Street and the Bikeway were identified early on in the process but were rejected due to feasibility, compatibility and cost issues.

Based on the analysis results, we recommend proceeding to detailed design of a new traffic signal at the Bikeway, coordinated with the existing signal at Brooks Avenue. More specifically, the following transportation safety and operations improvements are recommended for the Lake Street corridor:

- Form a Design Review Committee that will include members of DPW, APD, TAC, Walking in Arlington and ABAC to oversee the engineering design of the project. The committee will determine:
 - Signal phasing and timing, including different operations for different times and days (peak vs. off-peak; weekday vs. weekend)
 - Type of automatic passive detection on the Bikeway (infrared, microwave, video, bicycle loops)
 - Type of signal interconnection (radio, hard wire)
 - Need for audible pedestrian signals
 - Signal activation confirmation devices for users
 - Times when northbound left turn arrow on Brooks Avenue will be operational

- Type and location of signal equipment
 - Pavement markings and signage including:
 - Separate pedestrian and bicycle pavement markings crossing Lake Street
 - Signage (and possible electronic devices) to alert pedestrians walking on Lake Street of bicycles ahead on the Bikeway
 - Upgrade pedestrian ramps to ADA standards as required
 - Other measures to improve turning radii to/from the Bikeway and trimming/removal of vegetation adjacent to the Bikeway to increase sight distance
 - Monitoring of operations after installation of signal
- Install a new traffic signal at the 4-way intersection of Lake Street and Minuteman Bikeway. This will include traffic signal beacons on Lake Street and pedestrian countdown signals and bicycle signals on the Bikeway approaches. Push buttons and automatic passive detection will be placed on the Bikeway approaches to actuate the signal. A new signal controller at the Bikeway and a new master signal controller for coordination will be required. The exact placement of signal equipment, design of crosswalks and bike crossings, signage and stop bars on the Bikeway will be determined during the design stage.
 - Coordinate signal phasing and timing between the Bikeway and the signal at Brooks Avenue. Optimize signal timings. The type of signal interconnection system will be confirmed during design.
 - Install a new left turn arrow signal for the northbound Brooks Avenue approach to Lake Street.
 - Widen the Bikeway in the immediate area of the intersection to:
 - Provide a space for pedestrians and bicyclists to wait and segregate into separate lanes for crossing, and
 - Enable bicyclists to make the right turn from Lake Street to the Bikeway without moving into Lake Street traffic.
 - Trim/remove vegetation to improve sight distance.

Key features of the recommended improvements include:

- A new coordinated signal system that will reduce traffic delay and queuing, improve safety at the Bikeway crossing and be programmed for different cycle lengths for different time periods and days. The signal may reduce vehicle delay along the Lake Street corridor eastbound during the afternoon peak hour by 400 seconds and reduce vehicle queue length by 3,000 feet. The new signal system will be consistent with the newly installed two signalized crossings in Lexington.
- On the Lake Street eastbound segment approaching Mass Avenue, vehicle delay and queuing will increase during the afternoon peak hour. This could potentially encourage motorists to use Brooks Avenue southbound as a cut-thru route. This potential issue will need to be monitored.

If needed, signal timing adjustments can be reviewed as a technique to reduce delay and queuing on Lake Street at Mass Avenue. Other potential measures to consider if needed include signage and traffic calming techniques to prohibit or discourage cut-thru traffic.

- The new signal will reduce vehicle delay on Lake Street which may result in traffic on other routes shifting to Lake Street, increasing projected volume during peak periods. Some of this traffic would be to destinations outside of Arlington.
- Separate signals and pavement crossing markings at Bikeway for pedestrians and bicyclists.
- Establishment of Design Review Committee to evaluate and determine appropriate technology, signage and pavement markings.
- Consideration can be given to manually controlling the Lake Street/Bikeway intersection by a police officer for the purpose of observing traffic conditions with simulated signal operations. This would be done to replicate the coordination between signals at the Bikeway and Brooks Avenue. It is noted that manual control will not be able to perfectly replicate coordinated signal operations.
- A preliminary cost estimate for the design and construction of the recommendations is approximately \$150,000. A more detailed cost estimate will be developed as the project design advances.

INTRODUCTION

The Board of Selectmen requested that the Transportation Advisory Committee (TAC) evaluate alternatives to improve mobility and safety along the Lake Street corridor. Issues include:

- Vehicle congestion, delay and queuing on Lake Street, particularly eastbound during the afternoon peak period and westbound during the morning peak period;
- Vehicle congestion, delay and queuing on Brooks Avenue northbound at Hardy School during the morning peak period;
- Safety issues arising from conflicts among pedestrians, bicyclists and motorists at the intersection of Lake Street and the Minuteman Bikeway (Donald R. Marquis Minuteman Trail);
- Poor visibility and lighting of Bikeway from Lake Street; and
- Traffic congestion on Lake Street exacerbates the level of vehicles attempting to use other streets as cut-through routes.

Currently motorists experience long delays on Lake Street traveling eastbound and westbound during the weekday morning peak period (7:00 to 9:00 AM) and eastbound during the afternoon peak period (4:00 to 6:30 PM). Vehicle queues during peak periods can extend to Mass Avenue and halfway to Route 2 in the morning and to Route 2 and Cross Street (Belmont) in the afternoon.

Traffic congestion on Lake Street is due to 1) heavy peak period traffic volumes, some of which may include traffic diverting from congestion on parallel routes, such as Route 16; 2) limited roadway capacity (one travel lane in each direction plus signalized intersections); and 3) conflicts between motorists and Bikeway users. Bikeway users arrive at the Lake Street crossing in a random pattern. This situation causes traffic to stop in an unpredictable pattern on Lake Street at the Bikeway. Because of this unpredictability and poor visibility, Lake Street traffic often slows or stops at the Bikeway even when there is no traffic on the Bikeway. Traffic often must stop at both the Bikeway and the signal at Brooks Avenue. The green phase for Lake Street traffic at Brooks Avenue often goes largely unused because of traffic delays at the Bikeway crossing.

Safety issues at the Lake Street and Bikeway intersection include conflicts between motorists and Bikeway users, poor lighting and visibility. These issues are exacerbated by the behavior of some bicyclists and runners who fail to slow or stop before entering the intersection. While traffic congestion and delay along Lake Street is primarily limited to weekday commuter peak periods, safety issues at the Bikeway crossing are always present.

The goal of this study is to identify alternatives to improve traffic operations along the Lake Street corridor and to improve safety for all users.

The TAC Lake Street Working Group consists of Jeff Maxtutis (lead, TAC Vice-Chair), Howard Muise (TAC Chair), Wayne Chouinard (DPW, TAC), Scott Smith (TAC, ABAC), Seth Federspiel¹ (TAC), and Alan Linov (resident).

APPROACH

The TAC Lake Street Working Group obtained and reviewed existing traffic data and analysis results completed by others (FST, Mass Ave; VAI, Acorn Place) and collected new traffic and pedestrian/bike volume data along the study corridor in late April 2014. Accident data for the last five years was provided by the APD.

Jason Sobel, PE, PTOE was hired as a traffic engineer consultant to assist the working group to perform traffic operations analysis of alternatives for the Lake Street corridor. A traffic analysis model was created using Synchro/SimTraffic software. The model provided traffic and pedestrian Level of Service (LOS) delay, vehicle queues, and travel time results for the alternatives evaluated. Existing 2014 and future 2018 traffic volumes were evaluated.

Proposed intersection geometric and signal timing changes as part of the Mass Avenue Corridor Project were assumed at the intersection of Mass Ave/Lake Street.

EXISTING CONDITIONS

Geometrics. Lake Street is an east-west arterial roadway with one lane in each direction running between Mass Avenue and Route 2. West of Route 2 it continues to Pleasant Street (Rt. 60). Signalized intersections in Arlington include Mass Avenue, Brooks Avenue, and the Route 2 eastbound and westbound ramps. A striped shoulder of variable width is provided on both sides of Lake Street. There are sidewalks on both sides of Lake Street. The posted speed limit is 30 MPH. No Right Turn 4 PM-7 PM Monday Thru Friday signs are posted on several side streets west of Bikeway to discourage cut-thru traffic.

The Minuteman Bikeway has a crosswalk across Lake Street and Stop signs on both approaches for bicyclists. No street lighting is provided directly at the Bikeway. Pedestrian crosswalks are also provided on Lake Street at the signalized intersections and east of Wilson Avenue.

Volumes .New traffic, pedestrian and bicycle volumes counts were performed by the TAC working group in April 2014. Counts were recorded at Lake Street/Bikeway and Lake Street/Brooks Avenue during the weekday morning and afternoon weekday peak commuter periods.

Existing traffic volumes show Lake Street has approximately 800 vehicles westbound in the AM peak hour and 610 eastbound during the PM peak hour. Because of the substantial eastbound queuing on Lake Street during the PM peak hour, the 610 observed vehicles understate the actual demand.

¹ Seth Federspiel replaced Rich Turcotte who resigned from the TAC in November 2014.

Therefore, 800 vehicles was used to represent the eastbound actual existing demand during the PM peak hour. Historic traffic counts have shown volumes in this range. A total of 90 pedestrians and 165 bikes cross Lake Street at the Bikeway path during the morning peak hour (255 total) and 135 pedestrians and 195 bikes during the afternoon peak hour (330 total). Although formal counts were not taken, peak hour observation of the Lake Street/Bikeway intersection showed a significant number of pedestrians and bicyclists traveling along Lake Street, some of them turning to or from the Bikeway. Vehicle, pedestrian, and bicycle peak hour volumes are provided in the Appendix.

Crashes. Crash history on Lake Street was reviewed for a three and one-half year period between 2011 and June 2014. During this period 110 crashes were reported along the Lake Street corridor with 12 involving injuries. Four crashes involving bicyclists or pedestrians occurred at the Bikeway intersection with Lake Street, three involving injuries. It is noted that a few additional crashes have occurred at Lake Street and the Bikeway since June 2014.

Lake Street Operating Conditions. The following existing operating conditions were observed along the Lake Street corridor during weekday morning (7:00-9:00 AM) and afternoon peak periods (4:00-6:30 PM):

Morning Peak Hour

- Long westbound vehicle queues on Lake Street at Bikeway and Brooks Avenue extending back towards Mass Avenue
- Long eastbound queues on Lake Street extending halfway or more toward Route 2
- Long delays and queues for the northbound and southbound Brooks Avenue approach to Lake Street
- Conflicts between motorists and Bikeway users which exacerbates queuing on Lake Street. Motorists often have to stop at both Brooks Avenue and the Bikeway
- Delays and queuing at the Mass Ave/Lake Street intersection

Afternoon Peak Hour

- Long eastbound vehicle queues on Lake Street at Bikeway and Brooks Avenue extending back to Route 2
- Conflicts between motorists and Bikeway users which exacerbates queuing on Lake Street. Motorists often have to stop at both Brooks Avenue and the Bikeway. The green signal phase for Lake Street at Brooks Avenue is not fully utilized due to lack of coordination with Bikeway passage.
- Delays and queuing at the Mass Ave/Lake Street intersection

If bicycles are treated as vehicles, the intersection of Lake Street and the Bikeway meets the minimum requirements for a traffic signal based on Peak Hour Signal Warrant criteria provided in the Manual on Uniform Traffic Control Devices (MUTCD), 2009. It is noted that Lexington has two Bikeway crossings

that are currently signalized (Bedford Street and Hartwell Avenue) which likely have lower vehicle and Bikeway volumes during weekday peak hours.

ALTERNATIVES ANALYSIS RESULTS

A broad range of alternatives was initially identified to address the operation and safety issues. These include 1) Traffic Signal improvements; 2) Widening Lake Street; and 3) Grade Separation of Lake Street and the Minuteman Bikeway. Widening Lake Street was eliminated as an alternative as the impacts to abutters were significant, it would not by itself improve safety at the Bikeway crossing, and the cost would be prohibitive. Grade separation was also rejected due to cost, incompatibility with the adjacent residences, and the fact that it would not improve safety for those who must cross Lake Street at grade.

A traffic model was created for the Lake Street corridor including the signalized intersections with Mass Avenue and Brooks Avenue, and the unsignalized Bikeway crossing. The model was populated with year 2018 peak hour traffic volumes, roadway and intersection geometrics and intersection signal phasing and timing. The model was calibrated to reflect existing vehicle queuing and operations during the weekday morning and afternoon peak hours.

Six Signal Improvement Alternatives plus a No-Build condition were identified for evaluation as shown in Table 1. The traffic model was used to evaluate the weekday morning and afternoon peak hours for year 2018 conditions. It is noted that the signal improvements at the Mass Avenue/Lake Street intersection planned as part of the Mass Ave Corridor Project were assumed for analysis of all alternatives.

The No-Build Alternative would result in additional queuing and congestion along Lake Street as a result of increased vehicle, bicycle and pedestrian traffic by 2018. Alternatives 2 (half cycle times at Brook Street) and 6 (coordination with Mass Ave signal) were dropped because they showed no or minimal benefit.

Table 1 – Lake Street Corridor Alternatives

		Cycle Length (seconds)	
		AM	PM
No-Build	<ul style="list-style-type: none"> bike path unsignalized existing signal timing/phasing at Brooks 	100	100
Alt 1	<ul style="list-style-type: none"> signal at bike path, coordinated with signal at Brooks Brooks Signal optimized existing signal phasing at Brooks (protected NB Left) 	75	75
Alt 2	<ul style="list-style-type: none"> signal at bike path, coordinated with signal at Brooks Brooks Signal optimized existing signal phasing at Brooks (protected NB Left) 	100 at Brooks 50 at Bike Path	100 at Brooks 50 at Bike Path

Alt 3	<ul style="list-style-type: none"> • signal at bike path, coordinated with signal at Brooks • Brooks Signal optimized • all permitted turns at Brooks (no protected NB left turn) 	65	65
Alt 4	<ul style="list-style-type: none"> • bike path unsignalized • Brooks Signal optimized (but still semi-actuated) • existing signal phasing at Brooks (protected NB Left) 	80	90
Alt 5	<ul style="list-style-type: none"> • bike path unsignalized • Brooks Signal optimized (but still semi-actuated) • all permitted turns at Brooks 	65	80
Alt 6	<ul style="list-style-type: none"> • signal at bike path, coordinated with signal at Brooks and coordinated with signal at Mass Ave • Brooks Signal optimized • all permitted turns at Brooks 	100	100

Alternatives 1 and 3 include a new traffic signal at the Bikeway and show significant travel time and delay improvements over the No-Build condition. The results show:

- Reduction in Lake Street eastbound queue length at Brooks Avenue from over 3,600 feet to 500 feet (Alt 1) and 1,000 feet (Alt 3) during the afternoon peak hour. Some of the queue is pushed downstream to Mass Ave.
- Reduction in Lake Street corridor eastbound delay from 550 seconds to 150 second (Alt 1) and 225 seconds (Alt 3) during the afternoon peak hour.
- Average pedestrian/bicyclist delay at bike path crossing increases from 8 seconds for No-Build to 27 seconds (Alt 1) and 22 seconds (Alt 3). Pedestrian/bicyclist delay during the afternoon peak hour and non-peak periods will be lower.
- Alternative 1 improves Level of Service (LOS) at the Brooks Avenue northbound approach from 68 seconds (LOS E) for the No-Build to 42 seconds (LOS D) in the morning peak hour. Alternative 1 includes a northbound protected left turn phase on Brooks Avenue. There is an option to provide a protected left turn phase in the morning peak period and “permitted” (no left turn phase) at all other times.
- It is recognized that with Alternatives 1 and 3, some Bike path users may choose to cross against the signal. However, recent observations made by TAC working group members at the signalized Minuteman Bikeway crossings in Lexington have shown that many bicyclists and pedestrians (up to 75% on 11/9/14) obey the signal.
- The improvement in travel times shown for Alternatives 1 and 3 may induce additional traffic to use Brooks Avenue as a cut-thru in the afternoon peak period.

Alternatives 4 and 5 include signal optimization at Lake Street and Brooks Avenue, but Lake Street and the Bikeway remain unsignalized. Because Alternatives 4 and 5 did not show much improvement in terms of delay and travel time savings over the No-Build conditions, these two alternatives were eliminated.

Analysis results are provided in the Appendix.

Equipment. Alternatives 1 and 3 assume a new traffic signal at the Lake Street Bikeway crossing. This would include a traffic signal with standard signal heads for traffic on Lake Street and separate pedestrian and bicycle signals indications for the Bikeway path. The signal would be actuated on the Bikeway by 1) automatic passive detection plus; 2) a push button (similar to Lexington locations) and be coordinated with the Brooks Avenue signal. This approach would provide dual detection for Bikeway users and also push button detection for pedestrians walking along Lake Street who wish to cross Lake Street at the Bikeway. The options for a signal are for a traditional 4-way signal (ala Lexington) or a Pedestrian Hybrid Beacon (PHB), e.g. HAWK signal that is popular in the southwest. There are potential safety issues with using a PHB for both bicycles and pedestrians and the Federal Highway Administration (FHWA) Interim Approval for Bicycle Signals (2/12/14) does not allow bicycle signals in conjunction with PHB's. For these reasons the working group determined that a traditional signal is more appropriate if Alternative 1 or 3 are advanced. It appears there is adequate space to install new signal equipment at Lake Street and the Bikeway.

The signal beacon options for the Bikeway as part of a new signalized intersection include pedestrian countdown signals by themselves or with bicycle signals with green, yellow and red indications. The working group suggests providing both pedestrian countdown signals and bicycle signals, as were recently installed at the two signalized Bikeway crossings in Lexington. The FHWA Interim Approval for Bicycle Signals approves this operation. The FHWA must approve installation of bicycle signals, but it is understood that they will approve all written requests. The provision of both pedestrian and bicycle signals will provide a consistent regional signal operation for mid-block crossings along the Minuteman Bikeway in both Arlington and Lexington.



Figure 1 Bicycle/Pedestrian Signal (Minuteman Bikeway/Bedford Street Lexington, MA)

A new signal at Lake Street and the Bikeway will require a new signal controller at the Bikeway interconnected with the existing signal controller at Brooks Avenue. A new master controller will also be needed. The signal controller at Brooks Avenue will need to be inspected to determine if it can accommodate optimization and coordination with a new signal at the Bikeway.

A new signal system will be programmable so different signal timings and operation can be used for different days and different time periods to minimize delay for both motorists and Bikeway users.

Alternative 1 assumes that a new northbound left turn signal arrow will be provided on Brooks Avenue. A new arrow beacon would need to be installed on one of the signals if Alternative 1 is advanced.

RECOMMENDATIONS

Based on the analysis results, we recommend proceeding to detailed design of a new traffic signal at the Bikeway, coordinated with the existing signal at Brooks Avenue. More specifically, the following transportation safety and operations improvements are recommended for the Lake Street corridor:

- Form a Design Review Committee that will include members of DPW, APD, TAC, Walking in Arlington and ABAC to oversee the engineering design of the project. The committee will determine:
 - Signal phasing and timing, including different operations for different times and days (peak vs. off-peak; weekday vs. weekend)
 - Type of automatic passive detection on the Bikeway (infrared, microwave, video, bicycle loops)

- Type of signal interconnection (radio, hard wire)
 - Need for audible pedestrian signals
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 - Times when northbound left turn arrow on Brooks Avenue will be operational
 - Type and location of signal equipment
 - Pavement markings and signage including:
 - Separate pedestrian and bicycle pavement markings crossing Lake Street
 - Signage (and possible electronic devices) to alert pedestrians walking on Lake Street of bicycles ahead on the Bikeway
 - Upgrade pedestrian ramps to ADA standards as required
 - Other measures to improve turning radii to/from the Bikeway and trimming/removal of vegetation adjacent to the Bikeway to increase sight distance
 - Monitoring of operations after installation of signal
- Install a new traffic signal at the 4-way intersection of Lake Street and Minuteman Bikeway. This will include traffic signal beacons on Lake Street and pedestrian countdown signals and bicycle signals on the Bikeway approaches. Push buttons and automatic passive detection will be placed on the Bikeway approaches to actuate the signal. A new signal controller at the Bikeway and a new master signal controller for coordination will be required. The exact placement of signal equipment, design of crosswalks and bike crossings, signage and stop bars on the Bikeway will be determined during the design stage.
 - Coordinate signal phasing and timing between the Bikeway and the signal at Brooks Avenue. Optimize signal timings. The type of signal interconnection system will be confirmed during design.
 - Install a new left turn arrow signal for the northbound Brooks Avenue approach to Lake Street.
 - Widen the Bikeway in the immediate area of the intersection to:
 - Provide a space for pedestrians and bicyclists to wait and segregate into separate lanes for crossing, and
 - Enable bicyclists to make the right turn from Lake Street to the Bikeway without moving into Lake Street traffic.
 - Trim/remove vegetation to improve sight distance.

Key features of the recommended improvements include:

- A new coordinated signal system that will reduce traffic delay and queuing, improve safety at the Bikeway crossing and be programmed for different cycle lengths for different time periods and days. The signal may reduce vehicle delay along the Lake Street corridor eastbound during the afternoon peak hour by 400 seconds and reduce vehicle queue length by 3,000 feet. The new signal system will be consistent with the newly installed two signalized crossings in Lexington.

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- The new signal will reduce vehicle delay on Lake Street which may result in traffic on other routes shifting to Lake Street, increasing projected volume during peak periods. Some of this traffic would be to destinations outside of Arlington.
- Separate signals and pavement crossing markings at Bikeway for pedestrians and bicyclists.
- Establishment of Design Review Committee to evaluate and determine appropriate technology, signage and pavement markings.
- Consideration can be given to manually controlling the Lake Street/Bikeway intersection by a police officer for the purpose of observing traffic conditions with simulated signal operations. This would be done to replicate the coordination between signals at the Bikeway and Brooks Avenue. It is noted that manual control will not to be able to perfectly replicate coordinated signal operations.
- A preliminary cost estimate for the design and construction of the recommendations is approximately \$150,000. A more detailed cost estimate will be developed as the project design advances.