Implementation of Priority Bus Lanes (PBLs) in Washington, DC:
A Literature Review.

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Submission date: November 14, 2014

Word Count: 4,855 + 9 figures (250 words each) = 7,105
This study has an objective of exploring the challenges and possible benefits of including Priority Bus Lanes (PBLs) in the roadway networks in dense metropolitan areas. A PBL is restricted to only buses under certain conditions, and may be open to general traffic during other times or under other conditions. PBLs are generally used to speed up public transport that would be otherwise held up by traffic congestion without reducing the vehicle carrying capacity of the roadways (increasing the person carrying capacity). Several PBLs have been proposed for implementation in the District of Columbia to improve transit reliability thereby potentially increasing the use of mass transit. This study presents a review of PBLs to identify efficient implementations under different urban settings. The special case of the Lower Georgia Avenue Transportation Improvement plan in the District of Columbia that includes the implementation of PBLs is presented while different practices that contribute to the success of PBLs are also highlighted. Benefits and challenges related to design, operations, and policies implemented in the Lower Georgia Avenue Transportation Improvement Plan are compared to those found in the literature review.
1.0 BACKGROUND

Washington DC has a unique transit system that is very modern and extensive. It is composed of different services that are coordinated together. One of these services is the bus transit system. Washington DC introduced bus services after cancelling its streetcar system in the second half of the twentieth century, precisely in 1962 (1). Buses in the Washington Metropolitan area take riders to areas where the extension of rail system would not be a beneficial project, impractical, or would simply have negative impacts on the community. The bus network in the Washington Metropolitan area is very dense and involved. Figure 1 shows the Bus Network in Washington, DC. The District Department of Transportation (DDOT) and the Washington Metropolitan Area Transit Authority (WMATA) are the two responsible agencies that share the responsibilities of designing the street space, offering transit services, and setting up policies. DDOT and WMATA have been developing the bus network throughout the years and introduced additional services to increase the serviceability and improve ridership in the area. Different approaches were therefore used to attain those objectives.

Transit travel times have decreased throughout the years due to the success of some improvements both DDOT and WMATA made to the public roadways and operations of transit systems. Nowadays, the focus is to redesign street space for priority use by buses. This strategy took another perspective since the introduction of the new streetcar system.

![Shaded diagram of Washington DC Bus Network](source: WMATA.com)
Buses carry about half of the transit ridership of the Washington Metropolitan region (2). Metropolitan Washington has some of the most congested roadways in the nation, as well as one of the most complex operating environments for transit. Moreover, roadways in the District of Columbia often operate at far below their intended design speeds (2) and can have low Levels of Service (LOS), which make the congestion even worse.

In order to achieve the optimal performance and enhance the operations of transit bus systems, it is definitely essential to plan and study potential improvements to the capacity of the transit system as a whole. Given the fact that the volume of vehicles keeps increasing and the LOS of the public roadways keeps getting worse, it is envisaged that congestion will increase over time. One of the objectives of the Government of the District of Columbia is to reduce congestion by promoting the use of public transit. However, it is not simple to get the community attracted to do that; DDOT and WMATA should work diligently on increasing the capacity and the serviceability of buses by improving their operations or their operational environments. This could be done by modifying the actual street alignments to accommodate corridors where buses could operate at higher speeds. In fact, this solution could not only improve bus operations, but could also strike the right balance between transit systems and mixed traffic systems.

PBLs are generally well-suited for implementation in dense urban settings that have several bus networks. They have been undoubtedly proven efficient in many urban settings since their introduction in Nashville, Tennessee in 1955 (3). They made the buses more reliable, their schedules more predictable, and got the community to use public transportation more often. This could be seen from the increasing number of cities that expressed interest in PBLs and implemented them in their roadways since their introduction.

PBLs could potentially be an alternative to the rapid rail system since they are more flexible and cheaper. This allows them to be implemented in a very extensive and dense urban setting. Also, they could be kept and maintained for a long term throughout the Washington Metropolitan area if the right decisions are made and the ideal conditions are satisfied. The effects of PBLs on travel times and on enhancing travel speeds of buses in different mixed traffic scenarios need to be explored in order to determine if their implementation could be beneficial or not. The different effects are basically a reflection of the range of possible improvements to the operating environments. There are different practices used in the design and implementation of PBLs around the world. These practices do not necessarily reflect what is generally suitable or what would be the most efficient technique. However, the previously available scenarios and cases from other cities and from previous experiences in DC could provide guidance for the implementation of PBLs within the Metropolitan Washington region.

This study explores the different innovative improvements that could be made to the operating environment of transit systems in order to provide better transit services to the areas’ population and therefore provide a better quality of life while keeping the multimodal characteristics of roadways. A brief review of relevant research on PBLs implemented in selected cities is also presented while showcasing the summary of the guidelines used in the Washington Metropolitan area. The special case of the implementation of PBLs as a part of the Lower Georgia Avenue Transportation and Streetscape Improvements project and on 7th and 9th
Streets in Washington DC was also reviewed to determine if the proposed benefits could be realized.

2.0 METHODOLOGY
This research presents case study reviews of the implementation of PBLs in urban areas. The case studies present PBL characteristics related to their design, implementation and operations. In addition, engineers and planners involved in the Lower Georgia Avenue Transportation and Streetscape Improvements Project were interviewed to get their insight on the different innovative solutions to the issue of congestion throughout the public roadways in DC.

3.0 LITERATURE REVIEW
The use of bus lanes became an option in urban settings throughout the United States due to the lanes’ envisioned benefits. Researchers gave their full attention to the impacts of the implementation of PBLs, the different types of designs available, pavement markings and signage, and the strategies adopted for their enforcement. As a part of this research, information on the implementation of PBLs, showing the different types of designs possible, their hours of operation, techniques of marking and signage, and ways of enforcement was gathered. There is a range of treatments that jurisdictions opt for when dealing with PBLs. These treatments depend on the operations and the jurisdictions’ environment in which PBLs are needed. The main goal of all PBL treatments is to decrease the travel time of buses. When identifying solutions related to the operating environment, the first alternative is the placement of a simple travel lane that is designated for transit vehicles. This solution becomes insufficient when engineers start considering all the restrictions imposed by the nature of the roadways or the traffic conditions.

As mentioned earlier, there are many types of modifications that can be introduced to the public roadways in an urban setting to increase the transit reliability. These improvements depend on the conditions of the public roadways where their implementation is planned. The following sections present summaries of case studies from the literature review.

3.1 San Francisco
The City of San Francisco uses different types of PBL designs depending on the context of each corridor. The dominant design in San Francisco is the offset lane design (3). The intention was to preserve parking along the curbside and allow vehicles to use the lane for different purposes such as making deliveries or vehicles dropping/picking passengers. The rest of the PBLs throughout San Francisco have been assigned either the curbside or the median lane as their location. The only exception in San Francisco is Sansome Street that uses a contraflow bus lane (3). Pavement markings used throughout the city consist of solid white lines that serve to separate PBLs from general traffic. The use of messages marked on the pavement to designate the bus lane and its restrictions is general throughout the city. General traffic is not physically separated from PBLs when the location of the PBL is the curbside lane. However, bus islands are provided to serve as a physical separation of offset PBLs from general traffic (3).
PBLs in San Francisco are equipped with signs that display rules related to the use of the lanes, including operating hours and lane restrictions. These signs are placed throughout the length of the lanes and at their beginning to inform drivers that they are approaching a bus lane (3). Hours of operation for San Francisco’s PBLs depend on the conditions and needs of each corridor. There is no uniform trend used throughout the city. Some lanes operate during peak hours from 4 p.m. to 6 p.m. while others operate all day from 7 a.m. to 7 p.m. (3).

Different users are allowed to use PBLs in San Francisco depending on the city’s municipal code covering them (3). For example, private vehicles are allowed to use the curbside lanes to make right turns or access parking spaces in the case of offset PBLs. Delivery vehicles are allowed in truck loading zones along the lanes (3). Driving and parking illegally along PBLs in San Francisco are the major problems that prevent PBLs from reaching their full potential. Citations are issued to drivers who use PBLs illegally, however, the violations for which these tickets are issued are not considered infractions, which justify the high number of tickets issued. In spite of the wide variety of violations related to PBLs in San Francisco, it was concluded from a study done in 2006 that looked at PBLs violation rates that violation rates varied by corridor, but PBLs still proved to be very useful in providing a less congested road for buses (3).

3.2 New York City

New York City’s Department of Transportation (NYCDOT) has improved on its PBL implementation since its first introduction in 1963 as a curbside lane along Livingston Street in Brooklyn and on Victory Boulevard in Staten Island (3). During the past decade, the city used the offset lane as the main location for its PBLs in certain corridors (3). The purpose was to make the enforcement of PBLs easier than what it would be when the curbside lane is used. However, the majority of PBLs in New York City are curbside lanes (3).

New York City uses different PBLs pavement markings. Different color paint was used to identify PBLs from the rest of the lanes, as well as markings of the word “BUS” along the lanes (3). Moreover, many signs have been used to increase drivers’ awareness of PBLs and provide information about the hours of operations of the lanes, fines, and vehicle restrictions. These signs were also provided in different color schemes (3).

New York City’s PBLs do not have uniform hours of operation throughout the city. Some operate only during one of the peak hours (a.m. peak or p.m. peak) while others are open to buses throughout the day. Also, there are certain restrictions related to PBLs use in the city. Other vehicles can use PBLs during their hours of operation only to make right turns or in case there is a traffic conflict. However, parking is not allowed along PBLs during operation hours. Taxis or delivery vehicles are allowed to stop along the curbside lanes to pickup/drop-off passengers or to deliver goods (3).

New York City’s authorities issue tickets to drivers who park their vehicles or stand along the lanes. PBLs violations in New York City are considered infractions and result in point deductions from the driver’s license. There have been different problems related to PBLs in New York City related to the limited curb space, high pedestrian volumes, and narrow rights-of-way.
However, NYCDOT evaluated a couple of PBLs throughout the city and concluded that their implementation improved bus reliability, increased ridership, and decreased traffic injuries (3).

### 3.3 Los Angeles

The City of Los Angeles Department of Transportation (LADOT) started implementing PBLs in 1974 as contraflow lanes (3). This type of lanes created a couple of safety and operational problems. LADOT then decided to shift from this design to curbside concurrent flow PBLs. Pavement markings on PBLs in Los Angeles consist of solid white lines that separate PBLs from general traffic (3). Moreover, “BUS ONLY” messages are displayed on the pavement. Signs are used to inform drivers that there is a PBL ahead just before its beginning and provide information related to hours of operation and restrictions related its use by other vehicles (3).

Concurrent-flow PBLs in Los Angeles are open for other uses under certain conditions. Vehicles are allowed to use PBLs to make right turns at intersections (3). Emergency vehicles, utility vehicles, LADOT vehicles, and traffic officers are allowed to use PBLs when on official duty (3). PBLs parking related violation tickets are issued by traffic officers and are considered civil offenses. However, PBLs traffic related violation tickets are issued by the Los Angeles Police Department (LAPD) and could result in points on a driver’s record. There are mixed opinions with regards to the success of PBLs in the Los Angeles. Through a survey, most people agreed that the implementation of PBLs in Los Angeles brought positive benefits. Bus travel time improved the most during times of heavy traffic congestion along the corridor. However, vehicles making right turns delay buses significantly when right turning vehicles must wait for crossing pedestrians (3).

### 3.4 Paris

The City of Paris uses a vast network of concurrent flow PBLs that first started in 1964 (3). Recently, there has been a mixture of wider concurrent and contraflow lanes that are located on the curbside of the roadways. Most of the PBLs implemented throughout Paris are along one-way streets. Almost one third of PBLs in Paris are physically separated from general traffic, the rest are separated and designated using dotted paint lines. Moreover, the word “BUS” appears on PBLs throughout the city. Pavement markings indicate whether bicycles are allowed along PBLs. Signs related to PBLs alert drivers of the presence of PBLs throughout the corridors and present specific restrictions related to their use. PBLs in Paris are operational throughout the day (3).

Emergency vehicles, police vehicles, doctors, and taxis are all allowed to use PBLs any time throughout the day. Delivery vehicles are allowed to drive along PBLs and make deliveries in certain areas except during peak hours. Citations issued due to PBLs are considered civil infractions and do not impact negatively on drivers’ records. Studies that reviewed the changes in buses reliability after the implementation of PBLs in Paris have been contradictory and inconclusive (3).

### 3.5 Seoul
The City of Seoul uses only two types of PBLs. The Government of the City of Seoul developed a set of criteria that is used in the selection of the type of PBL to be implemented (3). Median bus lanes are used along corridors where there is excessive demand for public transportation, while curbside lanes are used where there is a moderate demand for public transportation. PBLs in Seoul are marked according to their hours of operation and restrictions. All PBLs have pavement markings that show hours of operation and “BUS ONLY” messages. There are posted signs along the roadways that alert drivers of forthcoming PBLs. These signs use different shapes and color patterns to make it easier for the drivers to recognize them (3).

The hours of operation of PBLs vary throughout the city but are consistent within each type of PBLs. Curbside lanes operate either during peak hours from 7 a.m. to 10 a.m. and from 5 p.m. to 9 p.m. during weekdays, or from 7 a.m. to 9 p.m. during weekdays. Median lanes operate at all times (3).

Vehicles are allowed to use PBLs in Seoul under certain conditions. Emergency vehicles, vehicles with disabled persons, and law enforcement vehicles are all allowed to use curbside PBLs at all times. Vehicles with 36-passengers or greater are the only vehicles allowed to use median PBLs. All vehicles are allowed to use curbside PBLs to make right turns or median PBLs to make left turns. Taxis are allowed to use PBLs to pick up passengers or drop them off as long as the process doesn’t adversely affect bus operations. All types of PBLs violations are enforced by Seoul Metropolitan Government and not by police officers. However, violations result in fines and may have an adverse impact on a driver’s record (3).

3.6 London

The Greater London Council (GLC) first introduced PBLs in 1968 in the city using curbside lanes. Currently, London has design standards that specify the location and design type of PBLs throughout the city, depending on the contextual conditions of each corridor. Solid painted lines are used to mark PBLs. Pavement is usually painted red with painted text that shows that the lane is a PBL. Posted signs inform drivers of the existence of PBLs and communicate information related to hours of operation and types of vehicles allowed to use it (3).

Some PBLs are reserved for use at any time during any day of the week, while others are restricted to 12-hour intervals or other specific time intervals. London allows emergency vehicles, police vehicles, garbage trucks, street sweeping vehicles, and mail vehicles to use PBLs at any time. Taxis are allowed to use most PBLs in London and may drop off or pick up passengers in some areas along the lanes. Moreover, bicyclists are allowed to use most PBLs throughout London. Penalties related to PBL violations in London are considered administrative penalties and do not adversely impact drivers’ records. There is a general agreement from the interviews performed in London that enforcement techniques used in the city allowed for the success of PBLs (3).
3.7 Summary

The dominant design throughout the cities explored is the curbside lane. This is mainly because of its low implementation costs and its minimal adverse impact on the capacity of the corridor. Figure 2 shows an example of a curbside PBL while figures 3 and 4 respectively present offset and median PBLs.

FIGURE 2 Curbside bus lane
[Source: nyc.gov]

FIGURE 3 Offset bus lane
[Source: web.mta.info]
There are a variety of pavement marking methods that could be used to communicate information related to PBLs. Most jurisdictions use colored pavements to distinguish PBLs from general traffic lanes. It should also be noted that restrictions of PBL usage were often displayed on sign posts. These restrictions can be related to the hours of operation of the PBL, the type of vehicles allowed to use the lane during some specific time frames, and whether vehicles are allowed to stop along the lane or not. Figure 5 showcases an example of pavement markings used on PBLs.
Signage is used to complement the information provided through pavement markings. The signs should make the drivers aware that they are approaching a PBL and that there are certain restrictions to its use. Hours of operation were also mentioned on the signs along PBLs. Signs could also use color schemes. Figure 6 shows an example of signs used along PBLs.

![FIGURE 6 Example of PBL signage](source: sheffield.gov.uk)

From the literature review, it could be noted that the hours of operation vary by jurisdiction. Each urban setting is unique and has a different population density and different roadway conditions. Even within a specific jurisdiction, hours of operations for PBLs vary.

Enforcement is an important factor to consider in order to achieve success PBLs implementation in any urban setting. There are many technologies that could be used in the enforcement of PBLs. However, each of these technologies have their advantages and disadvantages. The method of enforcement deployed depends on the authority that deals with parking and traffic infractions or violations. In some cities, PBL enforcement is done by the police department, which makes the violations considered infractions while in others, driving or parking violations in PBLs are only considered administrative violations.
4.0 REVIEW OF PBLs EXPERIENCE IN WASHINGTON, DC

4.1 The Lower Georgia Avenue Transportation Project

As the main transportation agency in the Washington Metropolitan Area, DDOT is committed to introduce transportation improvements throughout the district. One of the corridors considered for multimodal, balanced, and distinctive purposes is the Georgia Avenue corridor. The corridor has three Metrobus routes traveling along it with multiple bus stops. These buses carry more than 20,000 riders every single day along the corridor (4). In addition to the mixed traffic volumes, Georgia Avenue is one of the most traveled corridors in the Washington metropolitan area (4). Georgia Avenue has parked vehicles on both sides of the corridor, which impedes traffic and transit operations. In many of the portions along the Georgia Avenue corridor, parking demand is very low (4). Traffic data gathered from the studies show that intersection vehicular and pedestrian volumes increased especially from mid-day peak hours to PM peak hours (4). This reflects the congestion and the traffic issues during peak hours along the corridor. (4).

DDOT conducted a detailed study of the corridor and the multiple transportation improvements that could be added in order for the corridor to become multimodal. The study investigated the impacts that the improvements could have within the environs of the corridor and the most efficient strategies that could increase the use of the bus transit system. Several studies focusing on Georgia Avenue have been conducted in the past years, most which were dedicated to improving the transit system along the corridor (4).

Many transportation improvement alternatives were proposed by DDOT for implementation along the corridor. The objective of these alternatives is to make the blocks work with each other in order to improve the transportation operations and to achieve a more efficient transit operation system in the midst of the high vehicular volumes along the corridor. The alternatives proposed by DDOT could also affect the crash frequency along the corridor (4).

One of the alternatives provided focuses on the transit operations aspect of the corridor. The alternative includes the implementation of a curbside PBL along the length of the corridor (4). Thus, the current parking lanes on both sides of the corridor would have to be removed to accommodate the PBL.

Another recommendation focused on the congestion only along the Lower section of Georgia Avenue. This alternative suggests the removal of parking and the addition of a PBL from Barry Place to Florida Avenue given the high volume of vehicles between those two intersections (4). The type of the PBL changes depending on the block, using both an offset PBL and a curbside PBL. Figure 7 shows the PBL used for one of the alternatives recommended by DDOT.
The analysis of the applicability and efficiency of the different transportation alternatives introduced by the study was performed in order to make a recommendation. It was apparent that the transit focused alternative would be the most efficient alternative and the most beneficial in terms of having a low average delay and good LOS (4). The alternative that only introduces PBLs in congested area produces the same effects. They both reduce travel times and increase the ridership of the bus transit system (4). However, the second alternative has a multimodal vision of the corridor; it would provide a PBL to increase mobility of the bus transit system in congested areas of the corridor and wouldn’t disturb mixed traffic in other areas (4).

DDOT opted for the alternative that has a multimodal perspective of the corridor. This alternative has the ability of reducing congestion at hot spots, as well as improving the operations of all types of transportation means throughout the corridor (4). It is anticipated to allow motorists to still benefit from parking on most of the corridor’s length. In addition, this alternative will allow for more improvements to be included with regards to the general urban design of the corridor (4).
4.2 7th and 9th Streets PBLs

Washington, DC has another experience implementing bus lanes on its roadways. There are two Bus/Bike lanes on 7th and 9th Streets NW. Along with Georgia Avenue, these two corridors are considered two of the most heavily traveled due to the land uses they provide access to. On the southern side are landmarks, museums, corporate offices, federal buildings, and tourist attractions. On the northern side, access is provided to the central business district, Chinatown, shops and restaurants (5).

The PBLs on 7th and 9th streets were implemented in 2003 to accommodate a new Circulator bus route (5). A Bicycle lane was included in the design of the PBL. This PBL implementation forced DDOT to remove parking from one of the sides on some of the blocks. Also, the pavement marking is not obvious throughout the corridor, which might confuse some drivers. Figure 8 and 9 show street views of the PBLs on 7th and 9th Street, respectively.
It could be seen that in this case, WMATA, DDOT, and local bike organizations agreed that PBL implementation on both 7th and 9th Streets was not very successful because too many motorized vehicles use the lanes unlawfully (5).

**FIGURE 9** PBL on 9th Street Washington, DC NW

[Source: Google Street View]

5.0 Conclusions and recommendations:

There are different corridors that can be selected for the implementation of a PBL in Washington, DC. The selection of the corridor determines what potential effect the PBL could have on the operations along the corridor. The lane design selected should accommodate the mixed traffic flow, safe operation of buses, need for curbside access, and the safety of pedestrians. Transportation planners could choose from curbside lanes, offset lanes, and median lanes. Each of these lane designs have pros and cons, and a detailed study based on considerations such as parking needs and demand, traffic volumes, turning movements and land uses along each corridor should be performed to determine the suitability of the corridor. In some cases, it might be beneficial to use a combination of the alternative designs in order to accommodate the physical and operational characteristics of each roadway throughout the Washington Metropolitan area.

For the PBL implementation to be efficient throughout DC, there should be pavement marking and signing that is clearly identifiable by roadway users. Signs and pavement markings should comply with the specifications and standards set by DDOT. Pavement markings and signs should help in minimizing the number of drivers who might use the PBL during its dedicated times of operation by clearly communicating information related to its operation times and
restrictions. Signs should inform motorists of the fines associated with violating the PBL restrictions.

Specifying hours of operation depends on the transportation improvements DDOT thinks would be beneficial to the corridors. This will be based on the studies performed before the implementation of the PBLs. Hours of operation could be uniform throughout the city and could vary depending on the uses and conditions of each corridor or block. Making the PBLs have operation hours that satisfy the needs of the corridor will make their implementation more beneficial.

Enforcement is another critical aspect in the implementation of PBLs in Washington DC. DDOT and WMATA should work together to decide how enforcement for PBLs will be managed to ensure the success of the lanes and decrease the number of violations.

6.0 Acknowledgments

The authors would like to thank DDOT, Ms. Marsha Anderson Bomar, and Ms. Brittany Spell for their support and encouragement throughout the period of this study.

7.0 References


