Portland Area Mainline Needs Assessment

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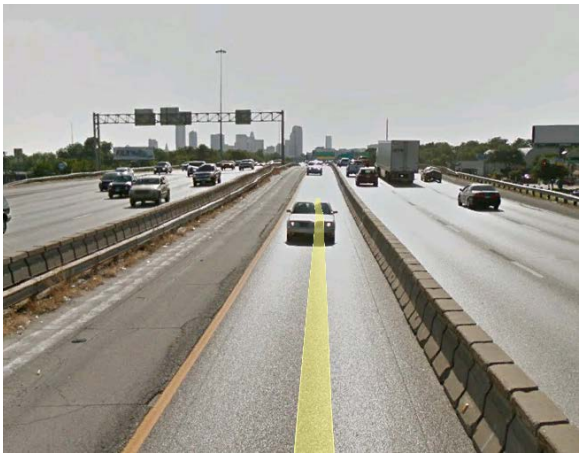
The Reversible Lane: Working Paper #4

The congestion-reduction potential of a single reversible lane



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1. Overview

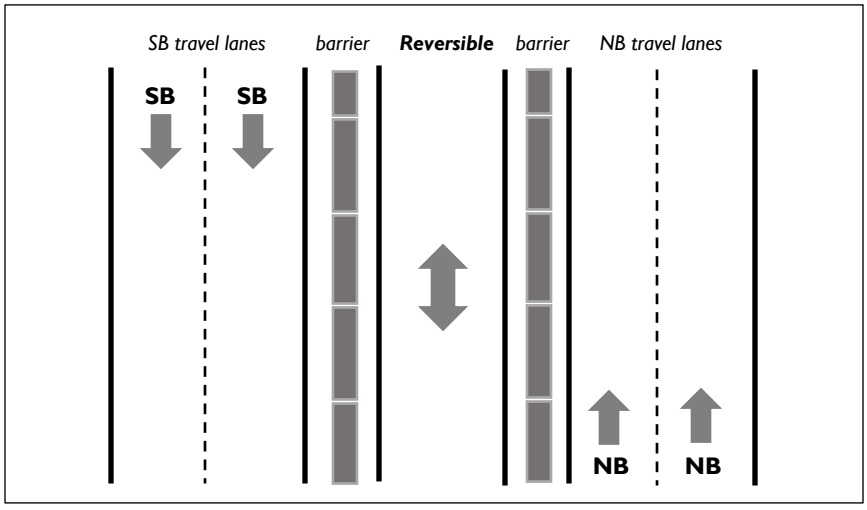
The purpose of this white paper is to provide a high-level assessment of the feasibility of using a Reversible lane to address the growing traffic demands on the Maine Turnpike in Greater Portland. The paper will focus primarily on traffic operations. It will **not** focus on exploring the constructability of such a lane, nor will it provide a detailed review of the capital or operating costs. Rather, the paper will focus on this question: Given the forecasted traffic volumes on the Maine Turnpike through 2040, might a Reversible lane provide the capacity required to meet the demands of peak-hour traffic in the years to come?

2. Reversible Lane Definition

For purposes of this analysis, a Reversible lane will be defined as a single, wide lane (12'-lane, 12' shoulder, 4' shoulder) constructed in the median of the Turnpike, whose orientation can be configured to serve traffic in the peak direction. During periods in which Northbound (NB) traffic was heaviest, the lane would be oriented in the NB direction, thus providing three general purpose lanes for NB traffic, while still providing two lanes for Southbound (SB) traffic. The same lane could have its direction reversed relatively quickly (e.g. an hour or less) to serve peak traffic in the SB direction.

The general concept of the Reversible lane is that it provides a barrier-separated additional lane in the peak direction of travel. The number of access points into the Reversible lane would be limited. Figure 1 provides a schematic overview of the Reversible lane.

Figure 1 – Reversible Lane Overview



Some specific characteristics of the Reversible lane assumed for this analysis are listed below:

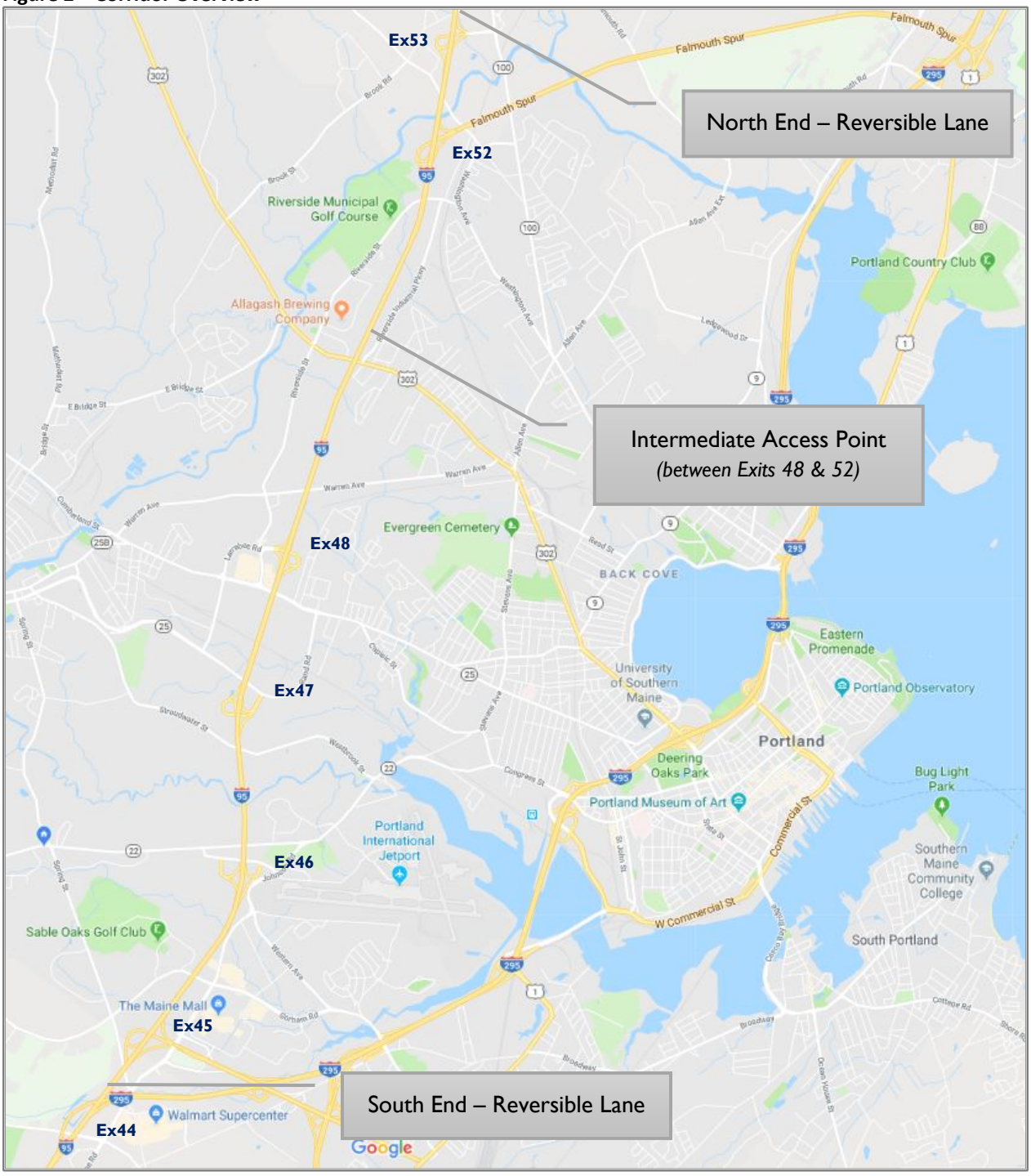
- The southern end of the Reversible lane would be at some point between Exits 44 and 45.
- The northern end of the Reversible lane would be at a point just north of Exit 53.
- Each direction would provide only two points of entry to the Reversible lane:
    - In the NB direction, the entry points would be (a) at the southern end, at a point between Exits 44 and 45; and (b) at some point on the segment between Exits 48 and 52.

  - In the SB direction, the entry points would be (a) at the northern end, at a point just north of Exit 53; and (b) at some point on the segment between Exits 48 and 52.

- Each direction would also provide only two points of egress from the Reversible lane:
  - In the NB direction, the egress points would be (a) at some point on the segment between Exits 48 & 52; and (b) the northern terminus at a point just north of Exit 53.
  - In the SB direction, the egress points would be (a) at some point on the segment between Exits 48 & 52; and (b) the southern terminus at a point between Exits 44 and 45.
- The full length of the Reversible lane would operate in the same direction, either NB or SB. The lane would **not** have the capability of serving NB traffic for one portion of the corridor and SB traffic for a separate portion of the corridor.

The Reversible lane represents an approach whereby a single lane is provided to support peak directional traffic flows. For safety purposes, the Reversible lane is barrier separated with limited access and egress points. Consequently, it is intended to serve vehicles that are making longer-distance trips through the corridor, rather than serving shorter distance trips within the corridor. On the following page, Figure 2 provides an overview of the corridor and identifies the key elements of the Reversible lane.

Figure 2 – Corridor Overview



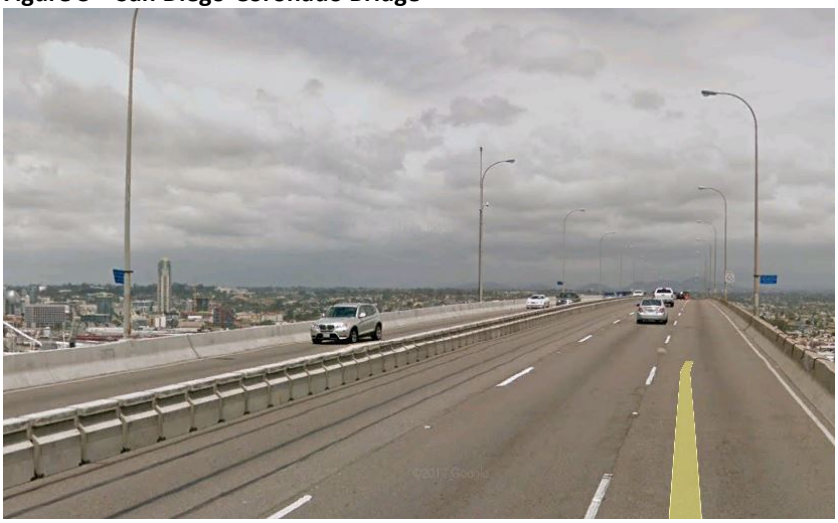
3. Reversible Lane Examples

Several facilities across the United States and Canada employ reversible lanes to serve alternating flows of peak-period traffic. A selection of these facilities is summarized below:

3.1 San Diego-Coronado Bridge

This five-lane bridge connects the cities of San Diego and Coronado in southern California. The middle lane was reversible, enabling the bridge to provide three lanes to serve peak directional flows.

Figure 3 – San Diego-Coronado Bridge



3.2 Old Tappan Zee Bridge

Prior to its replacement in 2017, the old Tappan Zee Bridge over the Hudson River provided seven lanes. With a reversible middle lane, the bridge could provide four lanes to serve the peak direction (eastbound in the morning, westbound in the evening).

3.3 Golden Gate Bridge

The Golden Gate Bridge has six lanes. Moveable barrier enables the bridge to operate in one of three configurations: 4 NB / 2 SB, 3 NB / 3 SB, and 2 NB / 4 SB. The balanced 3/3 configuration is the most common, but the imbalanced configurations serve intense peak-period traffic flows.

3.4 Lee Roy Selmon Expressway Reversible Lanes

This facility, operated by the Tampa-Hillsborough Expressway Authority, is a three-lane reversible facility that connects Brandon, Florida to downtown Tampa. All three lanes are devoted to the same direction of travel, serving Westbound (WB) inbound traffic in the morning and Eastbound (EB) outbound traffic in the evening. During the mid-day hours, the lanes have a split configuration, whereby the western portion of the facility serves WB traffic with the eastern portion of the facility serves EB traffic.

3.5 I-95 Express Lanes (Northern Virginia)

This facility, approximately 27 miles in length, operates between Garrisonville, Virginia and the Capital Beltway (I-495). It provides two lanes in the peak direction (NB in the morning, SB in the evening). The facility does **not** have the capability of providing one lane in each direction simultaneously. Access was controlled by gates at each possible entry point. Vehicles that have three or more occupants may travel

for free if they are equipped with a switchable transponder that enables the vehicle to designate itself as a high-occupancy vehicle (HOV).

3.6 Southeast Expressway

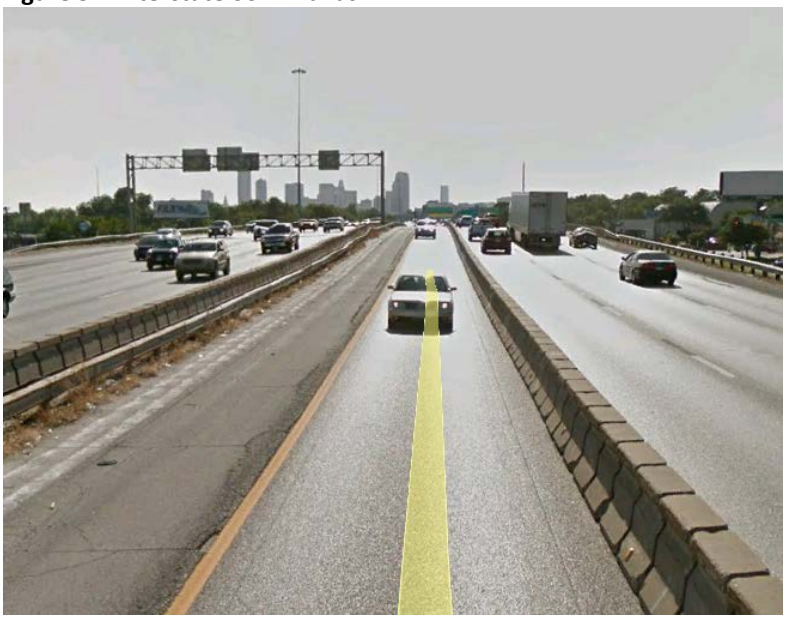
This 5.5-mile facility on Massachusetts State Route 3 operates between the Furnace Brook Parkway in Quincy and Morrissey Boulevard in Boston. The route has a total of eight lanes. In the morning peak (5am-10am), the facility operates with five NB lanes (heading toward Boston) and three SB lanes. In the evening peak (3pm-8pm), it operates with three NB lanes and five SB lanes (coming out of Boston). At other periods, the facility operates in its "original" configuration of four lanes in each direction. This facility actually has two sets of barrier (as illustrated in Figure 4), such that the vehicle in the "Reversible lane" has barrier on either side of it. When the lane operates in the 4 NB/4 SB configuration, the two sets of barrier are pushed together.

Figure 4 – Southeast Expressway in Boston

3.7 Interstate 30 in Dallas

This facility operates in a similar fashion to the Southeast Expressway. The I-30 Reversible lane is embedded within a 9-mile portion of I-30, also known as the East R.L. Thornton Freeway. The facility, which operates between South Haskell Ave. and North Galloway Ave., is primarily eight lanes. The Reversible lane enables the facility to operate with five westbound (inbound) lanes in the morning peak and five eastbound (outbound) lanes in the evening peak. Outside of the peak hours, the facility operates in a balanced 4 EB / 4 WB configuration.

Figure 5 – Interstate 30 in Dallas



Reversible lanes have been effectively employed on both bridges and on roadways as a means of better allocating capacity to support peak directional traffic flows. In some cases—such as the Lee Roy Selmon Expressway reversible lanes and the I-95 Express Lanes in Virginia—the reversible lanes represent *new* capacity added to relieve congestion. In other cases, the reversible lanes represented a means of mitigating congestion by more effectively utilizing *existing* capacity. Either way, reversible lanes provided a means for serving peak demand while minimizing the total number of lanes required on the roadway or bridge.

4. Potential Usage on I-95 in Greater Portland

The Reversible lane concept assumed as part of this analysis for the Maine Turnpike is similar to the concept employed on Route 3 in Boston and I-30 in Dallas. Access and egress points would be limited. As Figure 2 illustrates, access and egress was limited to the extreme ends of the corridor (i.e. between Exits 44 and 45 at the south end and just north of Exit 53 at the north end) and at one intermediate access point between Exits 48 and 52. Consequently, some groups of users would be unable to use the Reversible lane. For example:

- Any NB driver wishing to exit the Turnpike between Exits 45 and 48 would not be able to use the lane, since the first egress point is north of Exit 48.
- Any SB driver entering at Exit 52 would be unable to use the Reversible lane unless the destination was Exit 42 or south.
- **All** drivers whose origin and destination was between Exits 45 and 53 would be unable to use the lane.

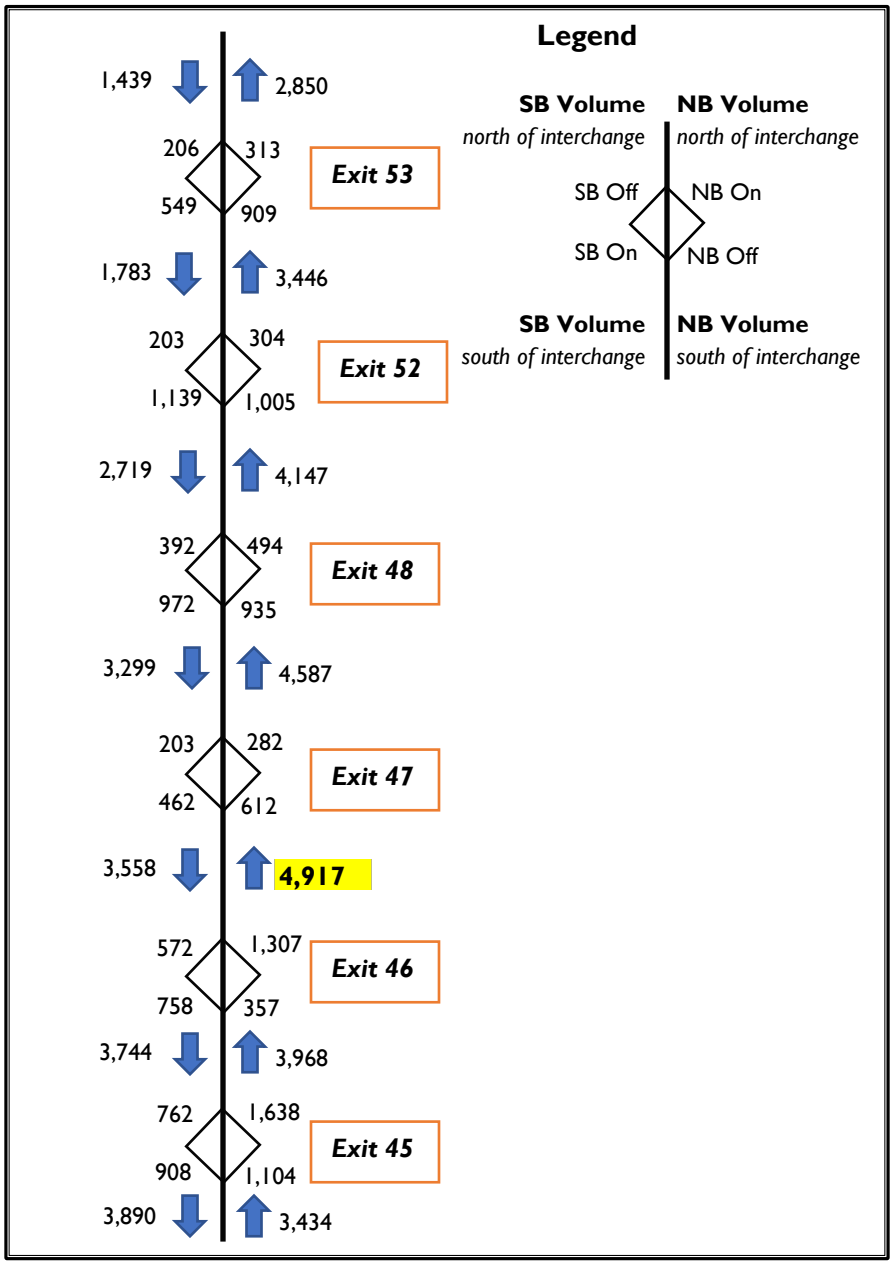
Therefore, it was necessary to examine the trip patterns of drivers through the corridor to examine whether a Reversible lane would be useable by enough drivers to make it useful. Trip patterns by E-ZPass

users in the peak hour were reviewed to estimate the extent to which the Reversible lane would impact traffic flows. These estimates are summarized in the following two subsections.

4.1 Northbound Usage

Northbound travel through the corridor experiences its peak during the afternoon on Fridays during the summer. Figure 6 summarizes the projected NB peak-hour traffic flows through the corridor in the year 2040.

Figure 6 – Projected 2040 NB Peak-Hour Traffic (Summer PM)



As Figure 6 illustrates, the peak NB volume is 4,917 vph between Exits 46 and 47 (highlighted in yellow). The key question is: Would a Reversible lane get enough usage to provide adequate peak-hour capacity?

To address this question, peak-hour travel trends of E-ZPass users were reviewed with the following results:

- Of all NB vehicles entering the corridor south of Exit 45, **52%** could potentially use the Reversible lane (i.e. vehicles were heading to destinations north of Exit 48).
- Of all NB vehicles traveling between Exits 48 and 52, about **56%** could potentially use the Reversible lane (i.e. vehicles were heading to destinations north of Exit 53).

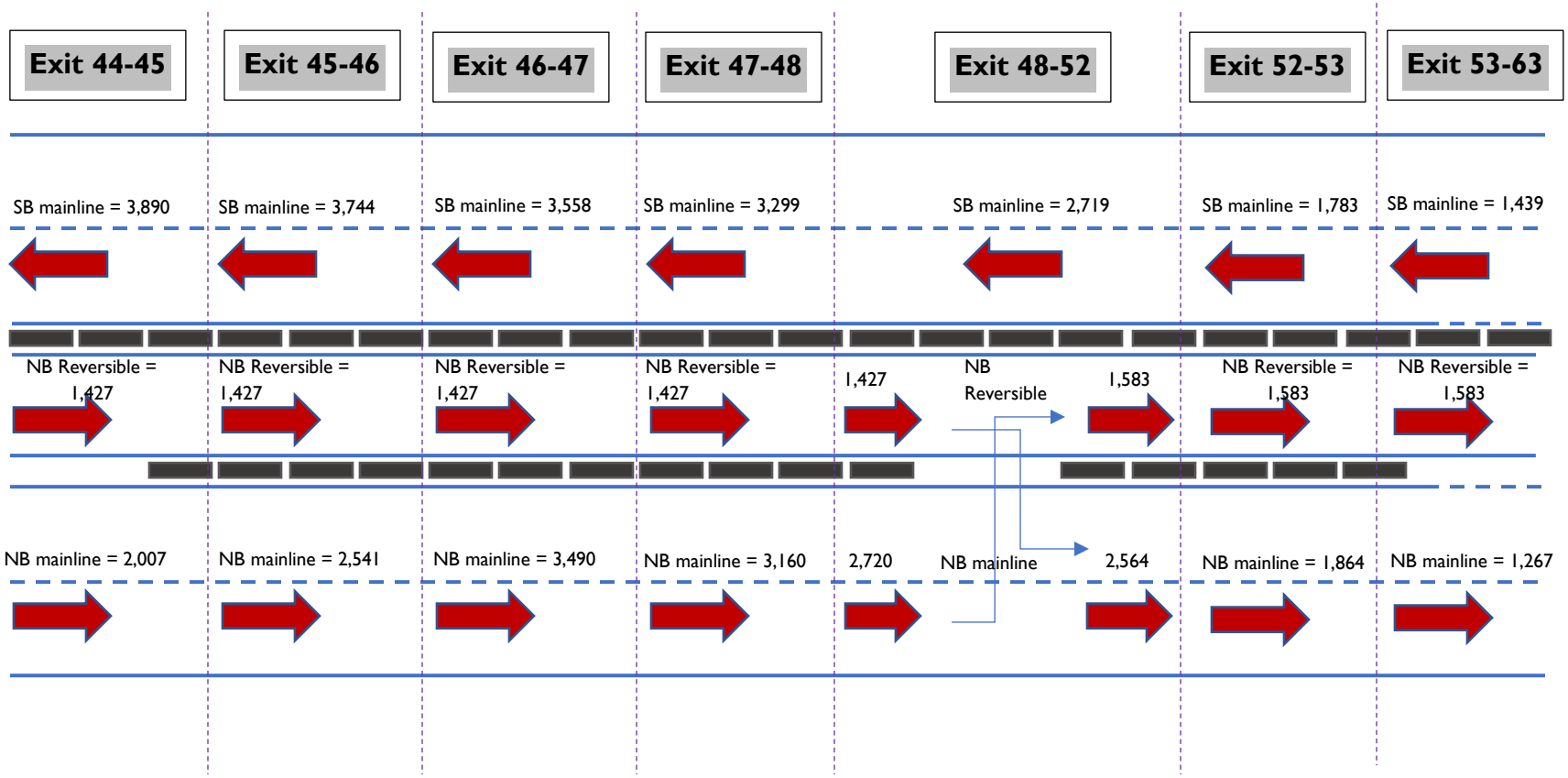
To predict utilization of the Reversible lane, the following two assumptions were made:

- At the southern entry point to the Reversible lane, 80% of travelers that *could* use the Reversible lane will choose to use it.
- At the intermediate access point between Exits 48 and 52, 50% of travelers that could use the Reversible lane will choose to use it. This percentage was lower than the assumed percentage at the southern entry point (80%) because this portion of the corridor was generally less congested. As a result, the Reversible lane would tend to provide less benefit.

Based on the analysis and the assumptions stated above, the mainline peak-hour volumes were calculated that could be expected with a NB Reversible lane during the 2040 PM peak. Figure 7 summarizes the results. When reviewing Figure 7, note the following:

- The diagram illustrates the mainline volumes corresponding to the segments of the Turnpike *between interchanges*. It does not illustrate the volumes on the intervening on- and off-ramps.
- Northbound traffic moves from left to right across the diagram. Southbound traffic moves from right to left.
- The black rectangular “blocks” represent barrier that separates the Reversible lane from the parallel general purpose (GP) lanes.
- The gap in the black blocks (in the segment between Exits 48 and 52) represents the intermediate access point between the GP lanes and the Reversible lane. At this point, Reversible lane traffic can shift to the GP lanes, and GP traffic can shift into the Reversible lane.

Figure 7 – Estimated Usage of the NB Reversible Lane during the 2040 NB Peak Hour (Summer PM)



The volumes summarized in Figure 7 suggest that a single Reversible lane oriented in the NB direction could be reasonably effective in supporting NB peak period traffic in 2040.

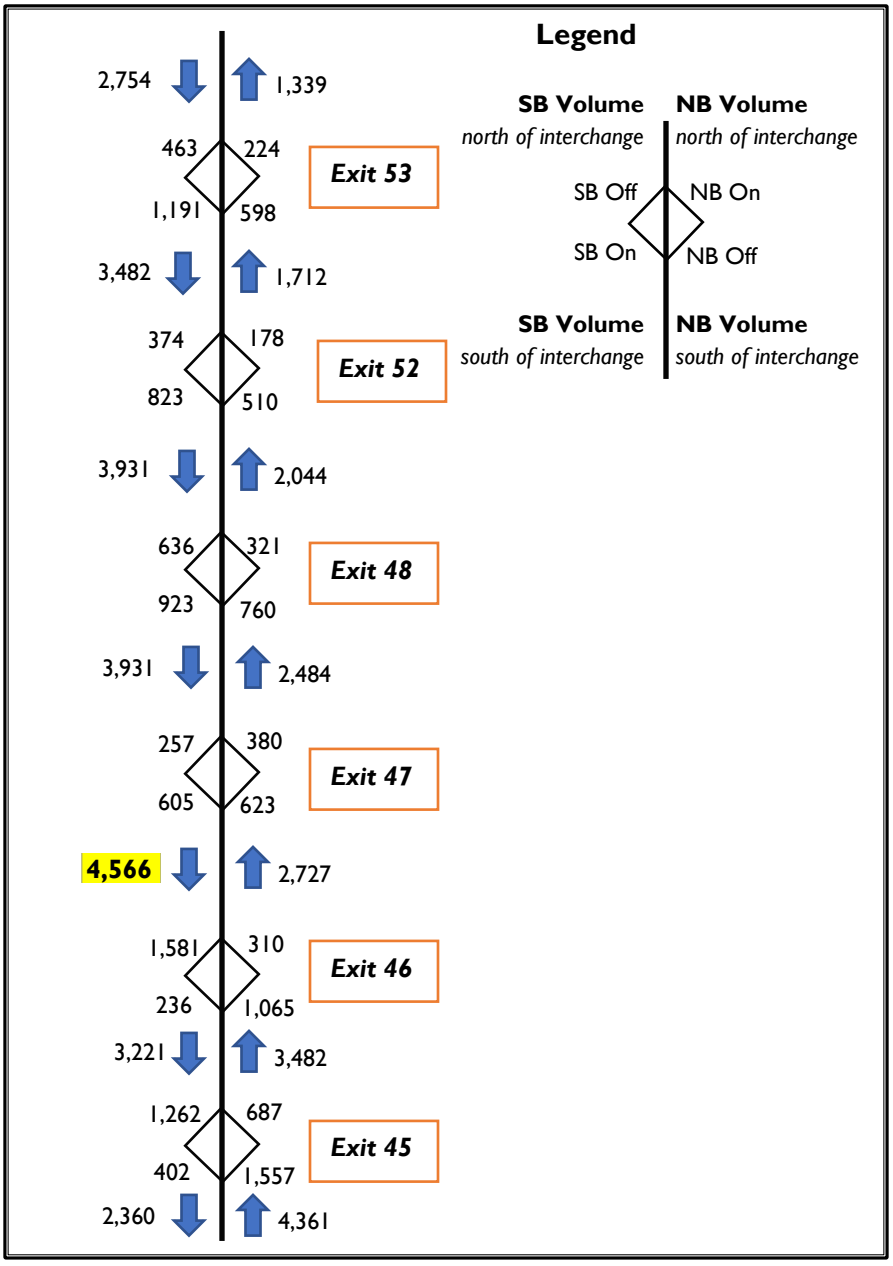
- The peak NB volume of 4,917 vph occurred between Exits 46 & 47. Nearly 3,500 vph was projected for the GP lanes—a heavy volume for a two-lane facility, but certainly within the assumed two-lane capacity of 3,600 vph. The remaining volume of 1,427 vph was allocated to the Reversible lane, which was well under the capacity of a single freeway lane.
- In the SB direction, traffic was very heavy south of Exit 47. Volumes reached nearly 3,900 vph between Exits 44 and 45—a level that exceeded the assumed capacity of 3,600 vph. However, the growth projections indicated that traffic levels between Exits 44 and 45 would not reach 3,600 vph until 2035.

Thus, it appeared that a Reversible lane would be adequate to support NB peak conditions for approximately the next 18 years. A configuration of three lanes to serve NB traffic would be sufficient to meet the peak directional demands, while the remaining two lanes would be sufficient for traffic moving in the off-peak direction.

4.2 Southbound Usage

Figure 8 depicts the projected SB peak-hour traffic flows through the corridor in the year 2040. Traffic in the SB direction reached its peak during the morning commuting period. Therefore, the SB peak period was represented by Fall AM peak conditions.

Figure 8 – Projected 2040 SB Peak-Hour Traffic (Fall AM)



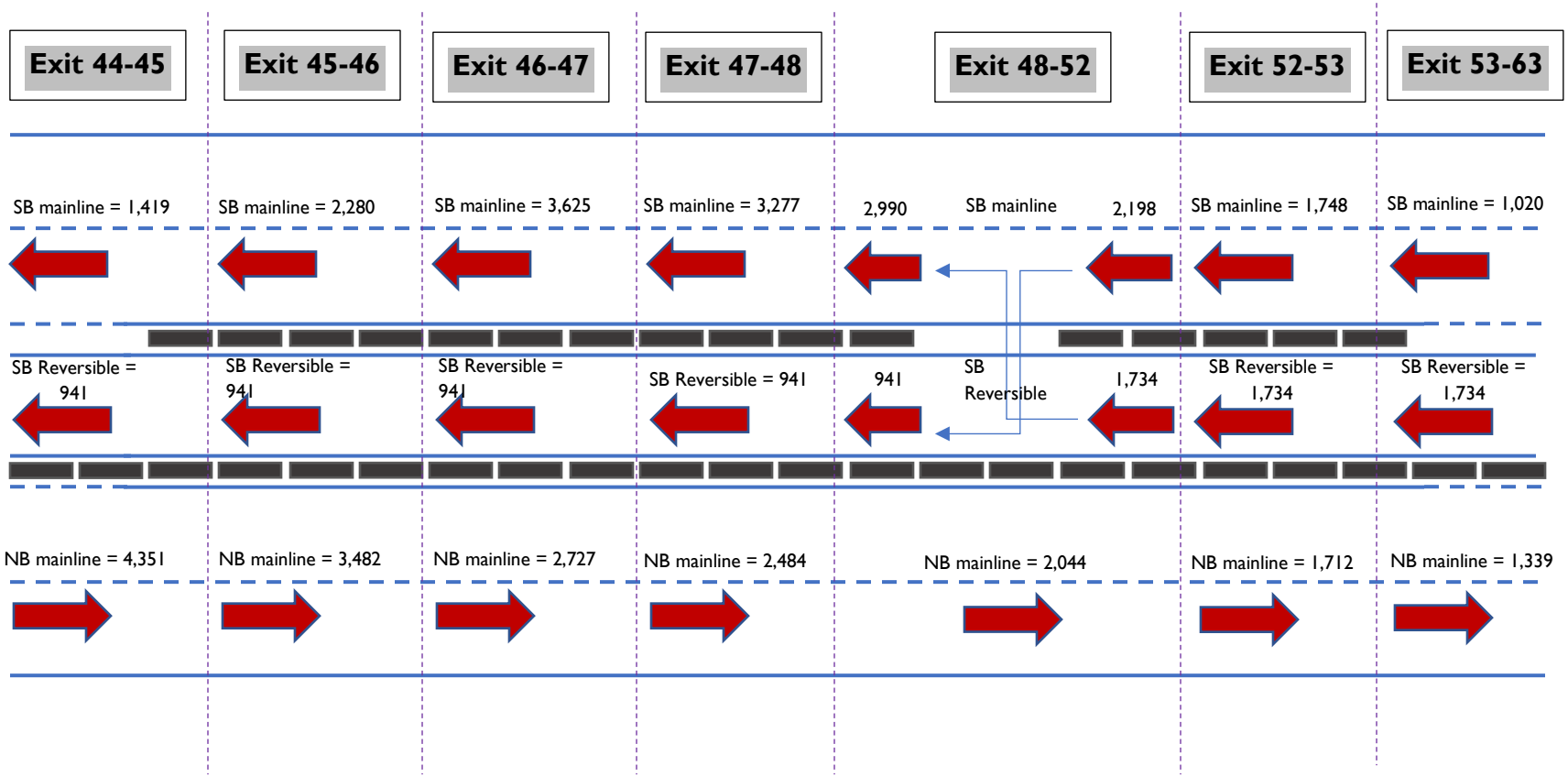
As with the NB peak volumes, trip patterns of E-ZPass users during the SB peak period were reviewed. This review indicated the following:

- Of all SB traffic approaching the corridor (north of Exit 53), **79%** would be able to use the Reversible lane—58% destined for Exits 45-48, and 21% destined for the south end of the corridor (with a destination of Exit 42 & south). The group destined for Exits 45-48 would need to exit the Reversible lane at the intermediate access point between Exits 48 and 52.
- Of all SB traffic on the mainline at the intermediate access point, **27%** were destined for Exits 42 and points south, and would therefore be able to use the Reversible lane.

It was further assumed that 80% of the vehicles that *could* use the Reversible lane (based on their destination) would in fact choose to use the Reversible lane.

Figure 9 illustrates the resultant volumes associated with a SB-oriented Reversible lane during the SB peak period (representing the Fall AM commuting period). As with Figure 7, this graphic depicts projected peak-hour volumes in the year 2040.

Figure 9 – Estimated Usage of the SB Reversible Lane during the 2040 SB Peak Hour (Fall AM)



Based on the volumes observed in Figure 9, it appears that a Reversible lane oriented in the SB direction would be adequate to handle traffic during the peak SB condition (Fall AM). As in the NB peak condition, the critical segment is between Exits 46 and 47. The segment volume of 4,566 vph is split between the GP lanes (3,625 vph) and the Reversible lane (941 vph). Granted, the projected GP volume slightly exceeds the assumed capacity of 3,600 vph for a two-lane section. However, this assumes that only 80% of the vehicles that *could* use the Reversible lane will in fact choose to use it. If this were to rise to 85%, then the GP lanes would be under capacity and the Reversible lane would still be flowing freely.

It is noted that the NB volume of 4,351 at the extreme southern end (between Exits 44 and 45) significantly exceeds the capacity of a two-lane freeway. However, given our knowledge of origin-destination patterns, the authors are confident that 300 to 500 of these vehicles are destined to connect to I-295 in South Portland. These vehicles are simply using the NB off-ramp Exit 45 to bypass the exit toll at Exit 44, and they will subsequently connect to I-295 via the loop ramp on Route 703. This, in part, explains the abrupt drop-off in NB volumes north of Exit 45. If these vehicles were to shift from the Exit 45 NB-off ramp to the Exit 44 NB-off ramp, the NB volume between Exits 44 and 45 would be much more manageable. However, it could be expected that traffic volumes will be near capacity from 2024 through 2035 resulting in undesirable levels of service (LOS E/F).

5. Summary

The analysis of peak-hour conditions in the Portland Area Mainline corridor (from Exit 44 to just north of Exit 53) identified two critical periods:

- Northbound traffic typically reached its peak during the afternoon on Summer Fridays. The peak NB volume associated with this period is 4,917 vph, occurring on the segment between Exits 46 and 47.
- Southbound traffic typically reached its peak during the morning on fall weekdays. The peak SB volume associated with this period is 4,566 vph, also occurring on the segment between Exits 46 and 47.

Reversible lanes have been employed at numerous facilities to provide traffic relief to regions that experience heavy directional peaks. The purpose of this analysis was to evaluate whether this application would be helpful in the context of the Portland Area Mainline corridor.

The analysis suggests that a Reversible lane could provide congestion relief during these peak periods through 2035, but with several drawbacks. In general, peak volumes through the corridor may be adequately served by providing three lanes (two GP lanes plus one Reversible lane) in the peak direction while maintaining two GP lanes in the off-peak direction. Some segments, particularly at the southern end of the corridor, however, will be stressed prior to 2035. The disadvantages of a Reversible lane include building near the amount of pavement required for the Reversible lane (32') as for widening for two additional lanes in each direction (44'), no safety or mobility relief for the non-peak direction, and the ultimate need for the second additional lane by 2035. Essentially, a reversible lane is a short-term capacity improvement until off-peak traffic drives the need for an additional lane.