Maine Turnpike Needs Assessment

Safety and Capacity Study

Prepared for:

Maine Turnpike Authority

Prepared by:

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EXECUTIVE SUMMARY

1.1 Purpose and Scope

The purpose of this assessment is to update the analysis of the safety and capacity needs on the Maine Turnpike (Turnpike) over the next 20 years. The Safety and Capacity Study was last updated in 2012, before recent traffic recovery. This study will assist the Maine Turnpike Authority (MTA) prepare its 30-Year and 4-Year capital plans, and identify areas that require additional planning level study.

This study provides an updated assessment of safety for the entire Turnpike including all mainline sections, ramps, toll plazas, and intersections of local roads with Turnpike ramps. This study also provides focused traffic operational analyses between Exit 1 in Kittery and Exit 80 in Lewiston. More specifically, the scope of this study includes:

- An analysis of crash data from MaineDOT along the entire Turnpike for the most recent three-year period for which data are available (2012-2014).
- A summary of updated design hour traffic volumes for 2014 for each mainline and ramp segment between Exit 1 and 80.[1]
- A forecast of future design hour traffic volumes at 10 and 20 year horizons.
- A highway and interchange capacity analyses for existing 10 and 20-year design hour traffic volumes for mainline and ramps.
- Additional simulation modeling analyses of the Portland area and the Biddeford/Saco area.
- The approximate timeframe and costs for needed capacity and safety improvements on the Turnpike.
- Recommendations for additional planning level studies of capacity needs south of MM 52 (the Falmouth Spur).

Maine's Sensible Transportation Policy Act requires transportation agencies to identify and analyze alternatives to widening roadways in order to achieve capacity and safety needs. These alternatives have not been identified as part of this evaluation, however, will be done as a separate planning effort when necessary.. Previous studies of such alternatives, have not eliminated the capacity needs identified.

1.2 Turnpike Assets

The Turnpike consists of 113 centerline miles of interstate highway designated as I-95 from Kittery to Augusta and the Falmouth spur. The original section from Kittery to Portland opened in 1947. The second section from Portland to Augusta was completed in 1955. In 2015, the MTA purchased the southerly 1.9 miles of I-95 in Kittery to the Piscataqua River Bridge abutment from MaineDOT. About 62% of the Turnpike length is a four-lane divided highway. The southerly 38% (from Exit 44 south) is a six-lane divided highway. Turnpike facilities also include 184 bridges, 18 minor spans, 22

[1] Design hour volumes are the 30th highest hour traffic volumes of a year.

interchanges, 19 toll plazas, 5 service plazas, 9 maintenance facilities, and the headquarters building in Portland which includes retail space for E-ZPass and a State Police headquarters.

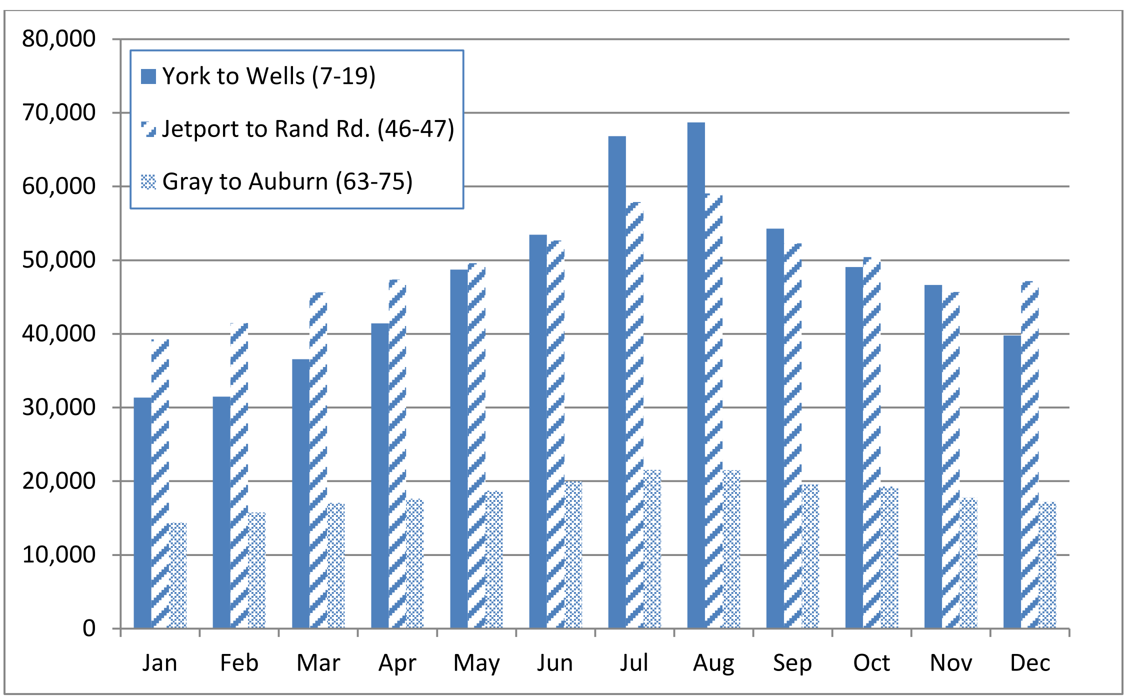
1.3 Current Traffic Observations

Based upon traffic data continuously collected by MTA traffic count stations located throughout the Turnpike, the following traffic information for the year 2015 was obtained.

- Total Vehicles for 2015: 66,208,867
- Northbound Vehicles per Day: 90,489
- Southbound Vehicles per Day: 90,905
- The mainline link between the New Hampshire border and Exit 1 carried the heaviest average volume: 73,751 vehicles.
- Wells, Kennebunk, Biddeford and Saco interchanges have heavier traffic volumes to and from the North (Portland area) than to the South.
- All northern interchanges from Rand Rd to Sabattus have heavier traffic volumes to and from the South (Portland area) than to the North.

As can be seen in Figure ES-1, the Turnpike, which was originally opened with the intention of accommodating tourism, still exhibits a strong seasonal component.

Figure ES-1 – Seasonal Variation (Mainline Segments)



A few observations can be drawn from Figure ES-1:

- During the busy summer months of July and August the highest volumes occur in the southern end of the Turnpike.

- During the remaining months (September through December and January through June) the 2 lane central section carries higher average traffic volumes.
- All regions peak during the summer tourist season.
- The summer month increase is less dramatic in the central section and the northern section. Volumes in the southern section essentially double in the summer months compared to winter volumes. By comparison, summer traffic in the central and northern sections is roughly 40-50% higher in the summer months compared to the winter months.

1.4 Safety Needs Identified

The safety analysis for this study determined:

- if there are locations with a high crash history;
- if there are measures that can be taken to alleviate the number of crashes;
- and examined the current safety practices of the Authority.

All mainline miles, interchanges, ramps and toll plazas on the Maine Turnpike were analyzed for this study. The high crash locations, number of crashes, and the Critical Rate Factor (CRF) – a measure of the crashes and their severity in relation to the traffic volume – are shown in Table ES-1.

Table ES-1 – 2012-2014 HCLs on the Maine Turnpike

	Town	*Description*	*Crashes*	*CRF*
Toll Plaza Nodes	York	Mile post 7.13 - NB approach to York Barrier Toll plaza	8	3.27
NB Segments	Saco	0.38 miles from Biddeford-Saco Town Line to Boom Rd.	16	1.05
	Falmouth	0.43 miles from Falmouth-Cumberland Town Line to Hurricane Rd.	13	1.58
	West Gardiner	1.0 miles from Litchfield-West Gardiner Town Line to West Gardiner Barrier Toll Plaza	8	1.11
SB Segments	Augusta	0.41 miles from Northern End Maine Turnpike to Augusta-Hallowell Town Line	12	1.20
	New Gloucester	0.49 miles from New Gloucester Barrier Toll plaza to Mayall Rd.	8	1.15
	Kittery	0.55 miles from New Hampshire-Maine State Line to Exit 1	26	1.10
Turnpike Ramps	Biddeford	0.13 miles from local street (toll plaza), Exit 32 On Ramp	8	1.43
	Saco	0.18 miles from Exit 36 Toll Plaza to I-195 Exit 1	9	1.57
	South Portland	Intersection of Turnpike Approach & Maine Mall Rd. On Ramp	12	3.29
Ramp Intersections With Local Roads	Kittery	Exit 2 Off Ramp & Rodgers Road	9	2.14
	South Portland	Exit 45 On Ramp & Maine Mall Rd.	37	1.35
	Portland	Exit 48 Off Ramp & Riverside Street & Larrabee Road	68	1.88
	Biddeford	Exit 32 Ramps & Alfred St & Biddeford Spur	56	1.14
	West Gardiner	Exit 102 Ramps & Route 9/126	13	13.68

As a result of the analysis, improvements were suggested to improve high crash locations. The suggested improvements are the following:

- Complete the York Toll Plaza replacement project.
- Install a "Reduced Speed Limit when Flashing" sign just south of the Saco River Bridge in the NB direction.
- Include the locations south of the Hurricane Rd. bridge in the NB direction, and north of the Falmouth-Cumberland town line in the NB direction in the Authority's review of large animal collisions
- Add a Roadway Weather Information Station to provide advance warning and roadway condition monitoring during storms (near Piscataqua River Bridge and on York River Bridge).
- Consider additional cameras on the section of Turnpike near Exit 1.
- Evaluate whether the capacity of the I-195 Exit 1 off ramp can be increased through the use of additional lanes or signal modifications.
- Consider pavement marking changes on I-195 EB to create a merge for traffic coming from the I-95 northbound off-ramp.
- Consider lane configuration changes at Exit 45 that would separate Maine Mall Rd. vehicles from SR-703 WB vehicles.
- Consider additional clearing on Maine Mall Road ramp to improve sight distance.

1.5 Capacity Needs Identified

Analysis of capacity needs requires of projection of future traffic volumes. Future traffic volumes on the Maine Turnpike were calculated using a fixed annual growth rate Annual growth rates were calculated for different sections of the Turnpike based upon historic traffic growth. The historic growth rate was applied to current peak hour traffic to develop future traffic volumes. Forecasted 10 and 20 year volumes were compounded annually using the 2014 data as base volumes. The growth rates used for this study for different sections of the Turnpike are summarized in Table ES-2

Table ES-2 – Annual Peak Hour Growth Projections

Region	**Annual Growth Rate**
Piscataqua River Bridge to the York Toll Plaza (Exit 7)	0.5%
York Toll Plaza (Exit 7) to Biddeford (Exit 32)	1.5%
Biddeford (Exit 32) to Scarborough (Exit 42)	1.6%
Scarborough (Exit 42) to W. Falmouth (Exit 53)	1.5%
W. Falmouth (Exit 53) to Lewiston (Exit 80)	1.1%

Capacity analyses using these projected traffic volumes demonstrates that there are no projected capacity needs from MM 52 (the Falmouth Spur) to MM 80 (Lewiston) over the next 20 years. These same analyses demonstrate capacity needs south of MM 52.

Suggested capacity improvements, are presented in Table ES-3 below. Included in Table ES-3 are possible future improvements, an approximate time table of when the improvements will become necessary, and an estimate of the forecasted construction costs. The years depicted in Table ES-3 are the year when LOS F will occur. Planning and completion of the project should occur prior to this date. The costs are shown in the LOS F year for information only. To summarize for budgeting purposes, Table ES-3 combines the cost of all projects proposed to begin in the same year. Actual years of construction and costs of proposed work need to be studied and other MTA planning materials may show differently due to traffic control needs, contracting analysis, coordination with other projects, permitting needs, funding availability and other issues.

Table ES-3 – Cost of Proposed Improvements by Year

Year	Total Forecasted Cost	Location of Proposed Improvement
2016	$ 1,038,200	Exit 44 I-295 Scarborough SB On-Ramp
2021	$ 4,621,900	Exit 36 Saco – NB On-Ramp **and** Exit 32 Biddeford SB Off-Ramp
2023	$ 14,690,000	Jetport to Westbrook – NB Mainline
2025[1]	$ 14,228,400	NH State Line to Kittery Exit 2 – SB Mainline **and** NB Mainline
2026	$ 36,229,880	I-295 Scarborough to Jetport – NB Mainline **and** Exit 32 Biddeford – NB on-ramp
2032	$ 102,061,100	Exit 36 Saco to Exit 42 Scarborough – SB Mainline, I-295 Scarborough to Exit 48 Westbrook – SB Mainline, Exit 48 Westbrook to Exit 52 Falmouth – NB Mainline, **and** Exit 36 SB Off-Ramp

[1]Traffic between Exits 1-7 is constrained by the Piscataqua River Bridge. Peak hour northbound traffic will not reach forecasted levels due to the traffic capacity constraint of the bridge. Conversely, peak hour traffic southbound will not benefit from widening if the capacity of the bridge is less than the mainline (i.e. if the bridge is not widened). Because of capacity issues, coordination with the New Hampshire Department of Transportation and the Maine Department of Transportation who jointly own the bridge will be needed in the near future.

1.6 Planning Study Needs Identified

This assessment indicated the need for additional planning level study and analysis to better understand capacity needs. Such additional study will allow more refined scopes and capital investment planning, assess environmental and landowner impacts and permitting risk, facilitate potential joint MaineDOT / MTA participation in projects, and gather needs and input from impacted municipalities. The following areas would benefit from additional planning level analysis.

- Kittery. The Turnpike is currently conducting a study on possible capacity enhancements regarding the Piscataqua River Bridge. It should be determined if there are any specific interim improvements MaineDOT could consider as part of their 2018 project.

- Potential Widening – Mile 43/44 to 48/49. Draft MTA capital plans include the following early widening projects: MCRR bridge in 2019, Stroudwater bridges in 2020 and a new Spring St. (Cummings Rd) bridge in 2021. A study for the widening of the turnpike in this area including determination of impacts, scope and schedule must be completed to support these early projects.

- Exit 45 / Gorham Spur. To properly contemplate a potential Portland area widening, further study of Exit 45 toll plaza and bridge needs, and whether a Gorham Spur is feasible, prudent, and permittable should be conducted.

- Saco – Biddeford Area. Exit 36 ramps & Exit 32 ramps are included in draft capital plans in 2021-2023 due to traffic volumes and Level of Service issues. Much discussion has occurred about local roads intersections and connections to the west to mitigate/eliminate some of these issues. These should be done in cooperation with MaineDOT and impacted municipalities.

2 INTRODUCTION

The following is a traffic operation and safety study of the Maine Turnpike (Turnpike) by HNTB Corporation, as requested by the Maine Turnpike Authority (Authority). This study includes an assessment of both current and future operating conditions between Exit 1 in Kittery and Exit 80 in Lewiston of interchanges, mainline sections, and ramps on the Turnpike. The section of the Turnpike from Exit 1 to Exit 53 was identified in the previous Safety and Capacity Study as having a possible need for improvements within 30 years. The segment north of Exit 53 to Exit 80 was identified by the Authority as an additional area of concern. Therefore, only these sections of the Turnpike were analyzed for this focused traffic operation analysis. This study also includes a system-wide assessment of safety for all mainline sections, ramps, toll plazas, and intersections of local roads with Turnpike ramps.

This study is intended to present an updated look at safety and capacity needs on the Turnpike over the next 20 years. The purpose of this study is to provide information on needed capital improvements to help guide the Authority in the drafting of the 30-Year Capital Plan. The Authority may also use this document for other purposes such as:

- Financial planning
- Construction planning
- Engineering
- Operations
- Maintenance
- Overall guidance

The parameters presented within this study include:

- A summary of current design hour traffic volumes (2014) for each mainline and ramp segment between Exit 1 and 80 Design hour volumes are the 30th highest hour traffic volumes of a year.
- A forecast of future design hour traffic volumes at 10 and 20 year horizons using applicable peak hour traffic growth rates and available forecasts.
- A highway and interchange capacity analyses for existing 10 and 20 year design hour traffic volumes for mainline and ramps.
- An additional simulation modeling analysis of the Portland area and the Biddeford/Saco area
- An analysis of crash data from the most recent three year period for which data are available (2012-2014) along the Turnpike from Kittery to Augusta using data from the Maine Department of Transportation (MaineDOT).

A series of recommendations are presented based on the data collected and results of the analyses performed. These include possible future improvements, an approximate time table of when the improvements will become necessary, and an estimate of the forecasted construction costs.

Recommendations are also provided to address current safety needs at critical mainline, ramp, and intersection locations along the Turnpike.

It is important to note that, due to limitations in forecasting, the only solution to projected capacity constraints analyzed in this study is the physical addition of capacity. The Authority remains engaged in the ongoing process of exploring options which allow the existing roadway to operate more efficiently which can, in turn, delay the need for additional capacity. Several of these options have already been implemented and are continuously being considered for upgrades. Current programs include the following:

- Programs designed to encourage alternatives to single-occupant vehicles such as carpooling and rideshare through GOMaine, Zoom Bus Turnpike Express and attention to the maintenance and expansion of park and ride lots.
- Providing real-time information on traffic incidents and conditions to third party software and application developers and service providers to broadcast this information to the public
- Utilizing social media to inform Turnpike patrons (who have signed up for the service) of traffic issues on the Turnpike
- VMS (Variable Message Signs) in locations where unexpected changes in traffic flow are being experienced. Common examples are lane closures and detours.
- HAR (Highway Advisory Radio) System. This is a radio frequency which is accessible to patrons at most points along the Turnpike. The AM station is constantly broadcasting. Warnings are broadcast whenever there are traffic delays, construction activity, or weather related issues.
- CCTV (Closed Circuit Television) which is used to continually monitor numerous areas along the Turnpike. The Authority has the ability, through mobile CCTV platforms, to deploy CCTV to areas where issues may be anticipated as conditions warrant.

These programs are examples of the Authority's ongoing practice of taking a proactive stance when exploring alternative methods to improve capacity constraints.

The limitations in the scope of this study make it important to consider that it is only one of several planning tools used by the Authority. An example of an existing planning tool is the annual inspection report. The annual inspection report is used to determine capital and reserve maintenance needs based on the *physical condition* of the infrastructure assets.

In summary, this study identifies the approximate timeframe and cost for needed capacity and safety improvements on the Turnpike. While other programs and/or policies might be developed to help address safety and capacity, including alternative transportation methods, this report provides information on when these issues will arise and also provides basic estimates for the engineering and construction costs of adding these improvements to the highway.

Maine's Sensible Transportation Policy Act requires transportation agencies to identify and analyze alternatives to widening roadways in order to achieve capacity and safety needs. These alternatives have not been identified as part of this evaluation, however, will be done as a separate planning effort when necessary.

Outside of the course of this study, specific projects and issues have been identified that are being addressed separately. They include the following:

- Relocation of the York Toll Plaza (MM 7.3)
- Improvements to the Scarborough I-295 Toll Plaza (Exit 44)
- Improvements to the Falmouth Spur Toll Plaza (Exit 52)
- Improvements to the Gray Interchange (Exit 63)
- Improvements to the Lewiston Interchange (Exit 80)
- Improvements to the West Gardiner I-95 Toll Plaza (MM 100.0)
- Improvements to the West Gardiner I-295 Toll Plaza (MM 103.0)
- Exit 102/Route 126 intersection improvements
- Gorham East-West Corridor Feasibility Study

Additionally, other possible improvements or projects may involve the need for advanced planning with MaineDOT, regional planning authorities, and local municipalities including:

- Capacity needs on the Piscataqua River Bridge (also includes New Hampshire Department of Transportation)
- Possible improvements to intersections adjacent to the Turnpike in Kittery, Wells, Biddeford, Saco, and Westbrook.

This study is written from a 2015 perspective using the most recent data available at the time. This study is an update to the previous Systemwide Traffic Operation and Safety Study that was completed in 2012. It is intended to be a working document which should be updated at regular intervals to account for changes in policy, traffic, and safety.

3 EXISTING CONDITIONS

In 1941, the Maine Turnpike Authority was created as an independent state agency and given the mandate to construct a turnpike "from some point at or near Kittery to a point at or near Fort Kent" as a means to help relieve congestion along coastal Route 1. The legislature delegated the responsibility for Turnpike construction, operation, and maintenance to the Authority and precluded any financial commitment by the state or federal government.

The original 45 miles of Turnpike from Kittery to Portland was opened to traffic in 1947 and Section II, from Portland to Augusta, was completed in 1955. In early 2015, the MTA purchased from the MaineDOT, 1.9 miles of the Interstate in Kittery. Almost two-thirds of the 111-mile Turnpike is a four-lane divided highway. The southern one-third is a six-lane divided highway. Turnpike facilities include 184 bridges (defined as any structure greater than 20 feet in length), 18 minor spans (defined as any structure 10-20 feet in length), 22 interchanges, 19 toll plazas, five service areas, nine maintenance facilities, and an administration building which includes retail space for Electronic Toll Collection (ETC), known as E-ZPass, and a State Police headquarters.

The Maine Turnpike is the major north-south highway in the state, extending from approximately 75 feet north of the Piscataqua River bridge joint at mile marker 0.3, to Augusta just south of Exit 109 (see Figure 2-1). The Turnpike today also includes a three-mile spur to Route 1 and Interstate 295 in Falmouth. The entire length of the Turnpike, from Kittery to Augusta, is designated as I-95. The Turnpike is the only interstate highway between Kittery and Portland, making it one of the most critical elements of Maine's transportation network. The Authority has recently purchased an additional 1.9 miles of interstate from the MaineDOT in Kittery which will extend the Turnpike closer to the New Hampshire state border.

Figure 3-1 – Map of Maine Turnpike

The demands placed on Turnpike facilities are enormous. Its roadways, bridges, interchanges, toll plazas, service areas, and maintenance areas are subjected to increasing stress due to age, traffic, and the demands of the harsh northern New England climate. To ensure the sound condition and effective operation of the Turnpike, the Authority has developed a 30 year plan which merges funding and the implementation of aggressive Operation and Maintenance, Reserve Maintenance, and Capital Improvement programs. The vigilance of the Authority through these programs has resulted in a well-maintained and efficiently operated Turnpike. The Authority will continue to improve Turnpike facilities regarding safety standards and projected demands.

3.1 Data Collection

The Authority collects and organizes extensive amounts of traffic data Turnpike-wide each year. The data being utilized in this study consists of those hourly traffic volumes continuously collected by the Authority's traffic count stations. These stations are located at every interchange and collect data from every on ramp, off ramp and mainline section of highway.

3.2 Traffic Characteristics

From the traffic data, the Authority can better understand the traffic patterns and historic growth of the Turnpike. The data provides information regarding variations throughout the mainline and among the interchanges. For example, some locations experience peak traffic during typical commuting periods, while other locations experience peak traffic that is more recreational or seasonal.

3.3 Average Annual Daily Traffic

Average Annual Daily Traffic (AADT) is a basic measure of the traffic demand for a roadway. The AADT data indicates approximately how many vehicles are moving through a section of the mainline on an 'average' day of the year. AADT can assist with future planning and in designing the structural elements of a roadway. AADT is calculated by taking the total volume of traffic on a highway segment for one year and dividing it by the number of days in the year. AADT is not used in determining capacity needs of the Turnpike. The traffic statistic that is used for purposes of determining capacity needs is the 30th highest hour traffic, which is discussed in Section 2.3.

Figure 2-2 provides a tabular summary of AADT for each ramp and mainline segment of the Turnpike in 2015. Each interchange is illustrated by a cluster of four boxes; each box represents a ramp merging or diverging to and from the mainline. The boxes to the left of the center line represent the southbound (SB) ramps, while the boxes to the right represent the northbound (NB) ramps. The boxes between each cluster represent the AADT for the section of mainline it is adjacent to. A legend is provided in the bottom right hand corner of the figure.

Figure 2-2 illustrates the following traffic information for the year 2015:

- Total Recorded Vehicles/Day: 181,394
- Northbound Vehicles: 90,489
- Southbound Vehicles: 90,905
- Total Vehicles for 2014: 66,208,867
- The mainline link between the New Hampshire border and Exit 1 carried the heaviest average volume: 73,751 vehicles.
- Wells, Kennebunk, Biddeford and Saco interchanges have heavier traffic volumes to and from the North (Portland area) than to the South.
- All northern interchanges from Rand Rd to Sabattus have heavier traffic volumes to and from the South (Portland area) than to the North.

Figure 3-2 – 2015 AADT Summary

	15,314	**15,354**
Gardiner I-95	11,318	11,540
Exit 103		
	3,996	**3,814**
Gardiner Remote		
Exit 102	796	977
West Gardiner Barrier	**4,792**	**4,791**
Sabattus	571	569
Exit 86	1,693	1,613
	5,914	**5,836**
Lewiston	1,579	1,678
Exit 80	4,431	4,336
	8,766	**8,494**
Auburn	3,708	3,714
Exit 75	4,325	4,228
New Gloucester Barrier	**9,384**	**9,008**
Gray	1,666	1,579
Exit 63	6,161	6,085
	13,878	**13,514**
West Falmouth	1,422	1,493
Exit 53	3,989	3,888
	16,445	**15,909**
Falmouth	1,187	1,434
Exit 52	5,083	4,173
	20,341	**18,648**
Portland/Westbrook	3,295	2,837
Exit 48	6,447	6,275
	23,493	**22,086**
Rand Rd.	1,545	1,613
Exit 47	3,316	3,507
	25,264	**23,979**

Congress St./Jetport	5,686	5,228
Exit 46	2,786	3,332
	22,365	**22,084**
South Portland	5,586	5,689
Exit 45	5,388	8,943
	22,167	**25,337**
I-295		
Exit 44	14,142	10,565
	36,310	**35,902**
Scarborough	2,672	2,725
Exit 42	3,630	3,610
	37,267	**36,787**
Saco	8,999	9,109
Exit 36	5,612	5,634
	33,880	**33,311**
Biddeford	10,437	10,217
Exit 32	2,522	2,682
	25,965	**25,777**
Kennebunk	3,500	3,273
Exit 25	1,892	1,965
	24,357	**24,468**
Wells	4,161	4,200
Exit 19	3,377	3,322
York Barrier	**23,573**	**23,590**
Chases Pond Rd. /	2,018	1,959
Exit 7	7,418	6,629
	28,973	**28,259**
Kittery	4,092	4,126
Exit 3		6,977
	24,881	**31,110**
Kittery		
Exit 2	10,683	2,789
	35,564	**33,899**
Dennett Road		
Exit 1	2,139	2,149
	37,703	**36,048**

Legend

SB Off	NB On
SB On	NB Off
SB Mainline	NB Mainline

Table 2-1 compares AADT volumes for all mainline sections over the past decade, from 2005 to 2015. This data identifies overall daily traffic trends for each mainline section of the Turnpike as well as the overall daily traffic trend for the entire Turnpike as recorded over the past 10 years. The rightmost columns contain the average annual change in traffic levels for the past 10 years and 5 years.

Table 2-1 demonstrates that AADT on some segments of the Turnpike have seen little growth over the past decade with an upward trend over the last 5 years.

- From the southernmost segment of the Turnpike up through Exit 44, traffic has trended upward over the 10 year period, with the average annual change at less than 1%. However, in the most recent 5 year period traffic has had a greater annual change upwards of 2%
- Between Exit 44 and Exit 48, traffic has trended downward at an average rate of 0 to -0.5% per year for the 10 year period. In the most recent 5 year period, however, the traffic trend has been positive 0.5-1% per year.
- The section of the Turnpike between Exit 53 and Exit 103 has seen a negative growth over the last ten years of about -1% to -2% per year. The most recent five year period has traffic trends that are similar to the last ten years.
- The Gardiner I-295 barrier has generally trended upward over the past decade. And its average 10 year annual growth level is 1.4%, and its average 5 year annual growth is 1.6%.

One potentially promising sign from Table 2-1 is that traffic in 2015 was up sharply compared to 2014. All segments exhibited growth of 2.6%-5.4% with most segments exhibiting growth more than 4% or more.

Table 3-1 – AADT Mainline Volumes (Vehicles/Day)

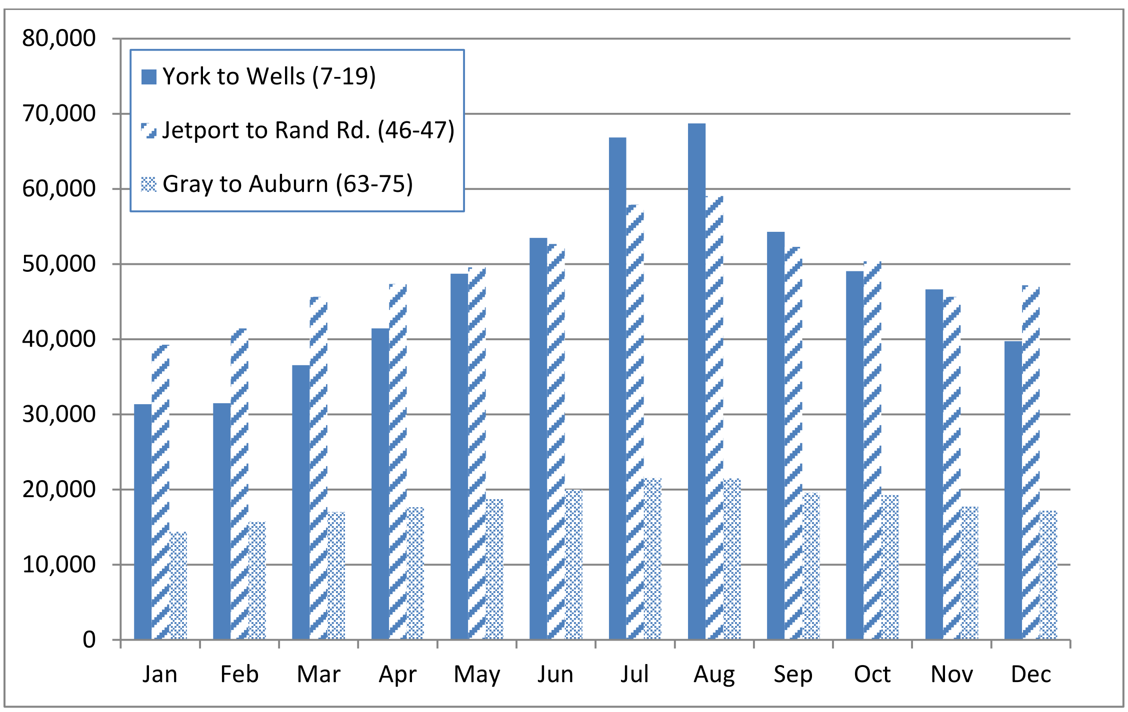
Segment	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	average annual change, 2005-2015	average annual change, 2010-2015
Ex3 (Kittery) – Ex7 (York)	56,988	57,204	56,963	53,419	53,656	54,137	54,774	54,233	54,036	54,820	57,184	0.03%	1.10%
Ex7 (York) - Ex19 (Wells)	45,366	45,899	45,587	42,884	43,046	43,724	43,415	43,529	43,585	44,969	47,115	0.38%	1.50%
Ex19 (Wells) - Ex25 (Kenn)	47,163	47,714	47,534	44,853	44,902	45,520	45,041	44,947	45,549	46,823	48,778	0.34%	1.39%
Ex25 (Kenn) - Ex32 (Bidd)	50,169	51,027	50,843	47,903	47,801	48,360	47,712	47,431	48,034	49,683	51,694	0.30%	1.34%
Ex32 (Bidd) - Ex36 (Saco)	61,620	62,358	62,939	59,898	59,813	60,533	60,296	60,357	61,679	64,502	67,143	0.86%	2.09%
Exit 36-42	68,921	69,434	69,425	67,063	66,247	67,507	67,442	67,047	67,909	70,437	74,006	0.71%	1.86%
Exit 42-44	67,503	68,008	68,136	65,838	64,806	65,948	65,762	65,365	65,991	68,497	72,164	0.67%	1.82%
Exit 44-45	47,532	47,680	47,376	45,883	44,548	45,238	45,671	44,897	44,011	45,340	47,456	-0.02%	0.96%
Exit 45-46	45,171	45,463	45,551	44,074	42,170	42,678	43,388	42,163	40,865	42,198	44,400	-0.17%	0.79%
Exit 46-47	50,651	51,251	51,036	49,439	47,237	48,078	48,284	46,939	45,423	47,006	49,196	-0.29%	0.46%
Exit 47-48	47,658	47,676	47,674	45,931	44,000	44,578	45,871	43,452	42,279	43,681	45,531	-0.46%	0.42%
Exit 48-52	42,710	42,584	42,006	40,231	38,950	39,559	39,098	38,116	36,484	37,124	38,941	-0.92%	-0.31%
Exit 52-53	34,372	34,014	33,950	33,321	32,634	31,969	31,349	30,879	29,647	30,711	32,306	-0.62%	0.21%
Exit 53-63	30,372	30,111	30,102	29,649	28,925	28,541	28,014	27,406	25,904	26,029	27,344	-1.04%	-0.85%
Exit 63-75	21,641	21,273	20,960	20,695	20,241	19,779	19,387	18,532	17,203	17,484	18,392	-1.61%	-1.44%
Exit 75-80	19,682	19,446	19,551	19,297	18,867	18,242	17,906	17,602	16,710	16,457	17,260	-1.30%	-1.10%
Exit 80-86	13,070	13,270	13,195	13,337	13,287	12,632	12,480	12,282	11,453	11,447	11,750	-1.06%	-1.44%
Exit 86-102	11,300	11,206	11,036	11,150	11,055	10,405	10,427	10,207	9,256	9,230	9,583	-1.63%	-1.63%
Exit 102-103	10,068	9,986	9,862	9,858	9,335	8,726	8,742	8,459	7,537	7,516	7,810	-2.51%	-2.19%
Exit 103-109	29,989	30,469	30,781	29,037	28,920	29,831	29,631	29,193	28,815	29,462	30,668	0.22%	0.55%
W Gard I-295 Plaza	19,921	20,482	20,918	19,179	19,585	21,106	20,889	20,734	21,278	21,947	22,858	1.38%	1.61%
Total Annual Trips (millions)	**62.22**	**63.18**	**63.39**	**61.31**	**59.95**	**61.10**	**60.44**	**60.60**	**60.70**	**62.85**	**66.21**	**0.62%**	**1.62%**

3.3.1 Seasonal Variation

The Turnpike was originally opened with the intention of accommodating seasonal traffic and still exhibits a strong tourism component. It is important to understand the seasonal variations in traffic levels on the Maine Turnpike. Because of fluctuations in traffic levels, an average summer weekday is sometimes much higher than an average winter weekday.

To demonstrate how traffic fluctuates seasonally on the Turnpike, three sections of the Turnpike were selected to display traffic variations. The section from the York to Wells Interchanges (miles 7-19) was chosen to represent the southern section of the Turnpike, which receives a lot of summer tourism traffic. The section from the Jetport to Rand Road Interchanges (miles 46-47) was chosen to represent the Portland region, which receives a lot of commuter traffic, but also summer tourism traffic. The section from the Gray to Auburn Interchanges (miles 63-75) represents the northern section, which receives less summer tourism traffic and a fair amount of commuter traffic. The seasonal traffic for each of these sections is shown in Figure 2-3.

Figure 3-3 – Seasonal Variation (Mainline Segments)



A few observations can be drawn from Figure 2-3:

- During the busy summer months of July and August the highest volumes occur in the southern end of the Turnpike.
- During the remaining months (September through December and January through June) the 2 lane central section carries higher average traffic volumes.

- All regions peak during the summer tourist season.
- The summer month increase is less dramatic in the central section and the northern section. Volumes in the southern section essentially double in the summer months compared to winter volumes. By comparison, summer traffic in the central and northern sections is roughly 40-50% higher in the summer months compared to the winter months.
- Approximately 30% of trips on the Turnpike occur during the summer months of June, July and August. Approximately 20% of trips on the Turnpike occur during the winter months of December through February.

3.4 Existing Level of Service Analysis

The existing traffic conditions of all merge, diverge, and mainline travel areas (referred to as basic freeway segments) were analyzed using current Highway Capacity Manual (HCM)[2] methods. The existing volume conditions evaluated in this document represent 30th highest volumes occurring in the year 2014. The Authority collects traffic count data at traffic count stations located to cover every ramp and mainline segment along the Turnpike. Those traffic counts were compared to similar traffic counts from previous years and adjusted if low due to construction activities or undercounting at the count stations. The 30th highest volumes are calculated as the number of vehicles traveling a roadway segment during the 30th ranked hour when the hours are organized from highest volume experienced to lowest. This design hour volume is a common industry standard in highway design.

All results are reported in terms of *Level of Service* (LOS), a qualitative measure describing operational conditions within a traffic stream. LOS is based on service measures such as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience. Letters designate each level ranging from A to F. A level of service of A represents the best operating conditions; LOS F, the worst. Most design or planning efforts typically use flow rates at LOS C or D to ensure adequate operating conditions. Conditions rated as LOS E or F represent unstable flows or a vehicle delay that is considered unacceptable. A more detailed description of LOS can be found in Appendix A. The general methodology and results of the analyses are outlined below.

3.4.1 LOS Analysis Assumptions

The parameters affecting Level of Service analysis consist of lane geometry, free-flow speed, driver familiarity with the roadway, the peak 15 minute traffic volume, and traffic composition (trucks, RV's and passenger car percentages). In this analysis the design hour volume was calculated for the 30th highest hour from the year 2014 data. A peak hour factor of 0.95 was used to compute the peak 15 minute volume. The list below contains the assumptions which were made based on current traffic data to complete the LOS analysis:

[2] Transportation Research Board. *Highway Capacity Manual*. Washington, D.C.: 2010.

- Based on previous speed studies taken on the Turnpike, a free-flow speed of 62 mph was used in all zones with posted speed limits of either 55 or 60 mph. In zones with either a 65 or 70 mph speed limit, a free-flow speed of 70 mph was used.
- Driver familiarity is captured in the model through a "driver population adjustment factor." A value of 1.0 is used when the drivers during the design hour are very familiar with the roadway (i.e. commuter). A roadway with a majority of recreational drivers who are not familiar with the roadway would have a driver factor of 0.85.
- After reviewing peak traffic conditions and calibrating the model with existing conditions, HNTB selected a driver population adjustment factor of 0.86.
- To determine a reasonable estimate for the ratio of trucks, recreational vehicles, and passenger cars operating on the mainline, average heavy vehicle percentages were obtained from toll plazas on the Turnpike that collect heavy vehicle data. From the traffic data, HNTB assumed a peak-hour blend of 7% trucks, 2% RV's, and 91% passenger cars.

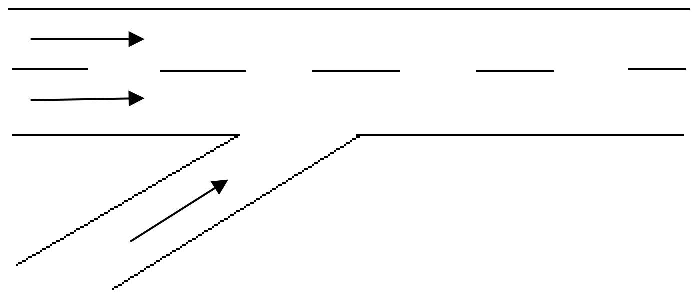
It is likely that the actual driver population factor will differ from one location to another. It is also likely that the blend of commercial vehicles and passenger cars will differ by location. But in order to provide consistency in the results, HNTB held the assumptions constant throughout the Turnpike.

The LOS analysis performed in this report will focus on the portion of the Turnpike between Kittery (Exit 1) and Lewiston (Exit 80). The section between Exit 1 and Exit 53 (West Falmouth) is the busiest portion of the Turnpike, and any future improvements will likely be targeted for this area. The section north of Exit 53 to Exit 80 is an area of concern identified by the Authority and is included in the anlaysis.

3.4.2 Interchange Merge Sections

A merge is defined as a movement in which two separate lanes of traffic combine to form a single lane without the aid of traffic signals or other right-of-way controls. In this situation the merge sections analyzed are on ramps at each interchange. The 30th highest hour traffic volumes for both the ramp traffic and the mainline volume were analyzed for every case. A visual representation of a typical merge area is shown in Figure 2-4.

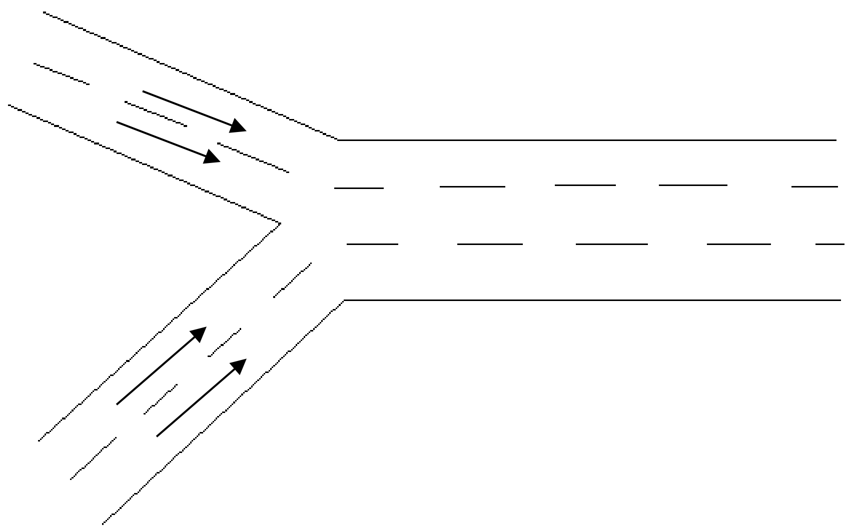
Figure 3-4 – Typical Merge Area



NON-TYPICAL MERGE CASES

The merge point at Exit 103 in the northbound travel lane where I-295 merges with the Turnpike is considered a major merge area. In a major merge, two primary roadways—each having multiple lanes—merge to form a single roadway segment. A visual of this form of major merge section is shown in Figure 2-5.

Figure 3-5– Major Merge Section



MERGE ANALYSIS RESULTS

Table 2-2 displays both the 30th highest hour 2014 traffic volumes for each on-ramp and the corresponding volume on the mainline at that time. For most locations, traffic volumes are shown for two distinct conditions:

- *30th High Ramp*. This depicts conditions on both the on-ramp and on the mainline when the **ramp** volume is at its 30th highest hour.

- *30th High ML.* This depicts conditions on both the on-ramp and on the mainline with the **mainline** volume is at its 30th highest hour.

In some instances, only the "30th High ML" condition is shown. In those instances, the ramps and the mainline segments peak at the same time periods and a 30th high mainline scenario would be similar to the 30th high ramp scenario.

As noted earlier, the focus of Table 2-3 and subsequent tables is on the portion of the Turnpike spanning from Kittery to Lewiston.

Table 3-2– 2014 Volumes at Merge Sections

Location	Exit #	Segment	NB-On 30th High Ramp	NB-On 30th High ML	SB-On 30th High Ramp	SB-On 30th High ML
Kittery	Exit 1	Ramp	N/A		N/A	208
		ML				4,965
Kittery	Exit 2	Ramp	N/A	602	N/A	1,449
		ML		4,288		4,757
York	Exit 7	Ramp	N/A	318	N/A	1,008
		ML		3,706		4,335
Wells	Exit 19	Ramp	504	415	N/A	503
		ML	1496	3,553		3,769
Kennebunk	Exit 25	Ramp	534	268	N/A	254
		ML	1,808	3,320		3,641
Biddeford	Exit 32	Ramp	1,373	886	251	200
		ML	2,881	3,910	2,553	3,334
Saco	Exit 36	Ramp	N/A	1,455	725	594
		ML		3,996	2,905	3,842
Scarborough	Exit 42	Ramp	292	263	N/A	409
		ML	3,378	3,919		4,180
I-295	Exit 44	Ramp	N/A		N/A	1,646
		ML				4,100
South Portland	Exit 45	Ramp	N/A	763	N/A	684
		ML		2,473		2,720
Jetport	Exit 46	Ramp	N/A	909	N/A	504
		ML		3,081		2,598
Rand Road	Exit 47	Ramp	211	178	N/A	350
		ML	1,637	2,894		2,754
Riverside	Exit 48	Ramp	N/A	494	N/A	610
		ML		2,677		2,577
Falmouth	Exit 52	Ramp	N/A	234	664	587
		ML		2,246	1,695	2,374
West Falmouth	Exit 53	Ramp	271	260	N/A	723
		ML	1,594	1,778		2,019
Gray	Exit 63	Ramp	231	168	N/A	969
		ML	823	1,089		1,790
Auburn	Exit 75	Ramp	N/A	477	463	349
		ML		1,035	945	972
Lewiston	Exit 80	Ramp	N/A	200	N/A	506
		ML		750		954

Note: "ML" indicates Mainline.

The LOS values for existing conditions are summarized in Table 2-3.

Table 3-3– 2014 LOS at Merge Sections

		NB-On		SB-On	
Location	Exit #	30th High Ramp	30th High ML	30th High Ramp	30th High ML
Kittery	Exit 1	N/A	N/A	N/A	D
Kittery	Exit 2	N/A	C	N/A	E
York	Exit 7	N/A	C	N/A	D
Wells	Exit 19	A	C	N/A	C
Kennebunk	Exit 25	A	B	N/A	B
Biddeford	Exit 32	C	C	B	B
Saco	Exit 36	N/A	D	B	C
Scarborough	Exit 42	C	C	N/A	D
I-295	Exit 44	N/A		N/A	D
South Portland	Exit 45	N/A	C	N/A	C
Jetport	Exit 46	N/A	D	N/A	C
Rand Road	Exit 47	B	C	N/A	C
Riverside	Exit 48	N/A	C	N/A	C
Falmouth	Exit 52	N/A	C	B	C
West Falmouth	Exit 53	B	B	N/A	C
Gray	Exit 63	B	B	N/A	C
Auburn	Exit 75	N/A	B	A	A
Lewiston	Exit 80	N/A	A	N/A	A

SUMMARY OF FINDINGS

Two important observations may be drawn from Table 2-3:

- All of the merge areas are currently operating at acceptable levels of service. All are operating at LOS D or better except the merge area at Exit 2 southbound.

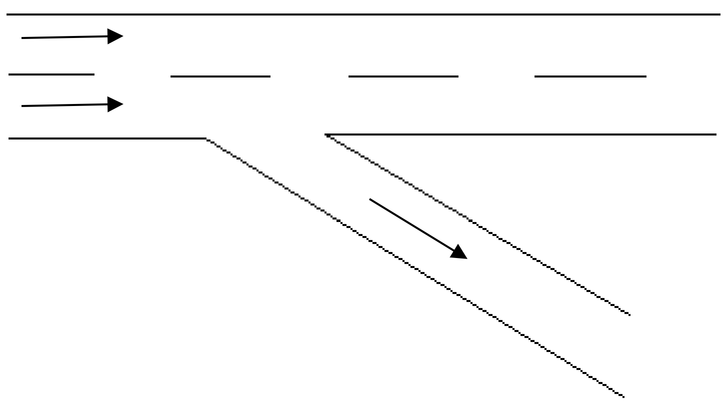
- In every instance in which both the "30th High Ramp" and "30th High ML" results were reported, the "30th High ML" condition had the lowest level of service. In other words, critical merge conditions are more governed by heavy volumes on the mainline than they are by heavy volumes on the ramp.

3.4.3 Interchange Diverge Sections

A diverge is defined as a movement in which a single traffic stream separates into two traffic streams without the aid of traffic control devices. The diverge sections analyzed are off ramps at each interchange. Unlike the merge sections, the diverge sections can be influenced by downstream intersections, particularly signalized intersections. Poor operations at downstream intersections can create queuing that interferes with the operation of the diverge section. The planning level analysis in this report does not capture the impacts of adjacent intersections on traffic operations.

The 30th highest hour 2014 traffic volumes were found for both the ramp traffic and the mainline traffic. Both of these scenarios were analyzed for every diverge section. A visual representation of a typical diverge area is represented in Figure 2-6.

Figure 3-6 – Typical Diverge Section



NON-TYPICAL DIVERGE CASES

Three interchanges along the Turnpike have diverge areas that are considered non-typical, Exits 36, 44, and 103. These diverge areas were analyzed by methods described in the following sections.

Exit 36

The exit 36 northbound off ramp is preceded by an on ramp which services the Saco Conference Center. Since these two ramps fall within a 1,500 foot distance of each other the area is classified as a weave section and analyzed using a different method. Figure 2-7 depicts a Type A weave area (as defined by the Highway Capacity Manual). Figure 2-8 shows the paths of travel analyzed as inputs.

Figure 3-7– Type A Traffic Weave Segment

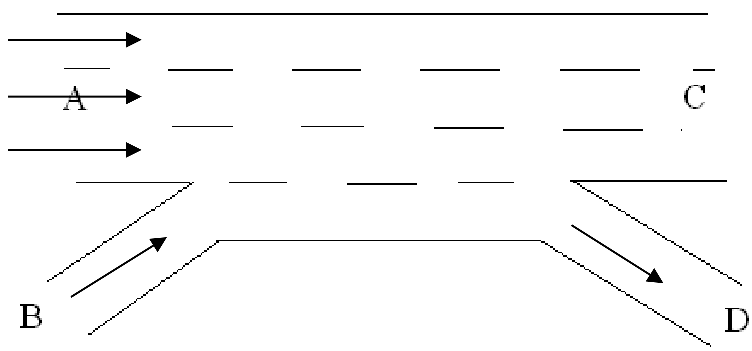
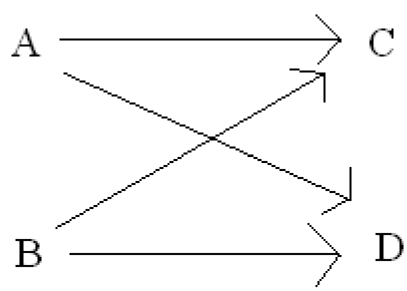


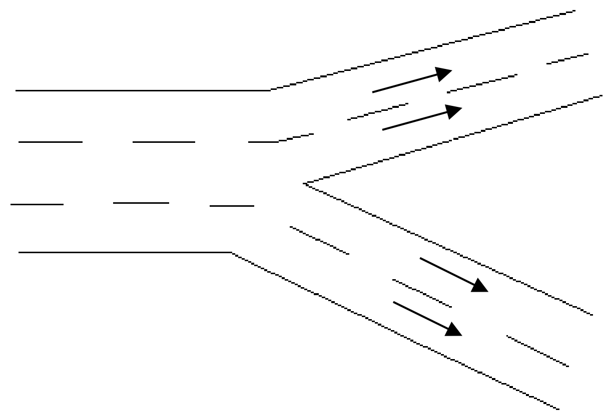
Figure 3-8– Travel Paths in Type A Traffic Weave Segment



Specific data concerning the volumes of traffic from stations A-D, A-C, B-D, and B-C as shown in the above diagram were not known. The volume from station B-D was assumed to be small amount of traffic, about 5% of the 687 vehicles counted at point D. Volume B-C was assumed to be a traffic volume similar to volume B-D, which is a relatively small fraction compared to the known mainline volume A-C of 3,900 vph.

Exit 44 in the northbound direction has a two-lane off ramp. The geometry of this configuration is shown in Figure 2-9.

Figure 3-9– Major Diverge Section



This is not a case that can readily be analyzed by HCM methods. For this particular case, equation 13-26 from the Highway Capacity Manual was used. The equation reads:

$$D_{MD}=0.0175*V_f/N$$

where

N=number of lanes approaching major diverge
V_f=demand flow rate immediately upstream, of the major diverge influence area (pc/h)
D_{MD}=density in the major diverge influence area (which includes all approaching roadway lanes) in passenger cars/hour

The density value calculated was then converted into a LOS rating using Exhibit 25-4 in the Highway Capacity Manual. The detailed calculations can be found in Appendix B.

Table 2-4 displays both the 30th highest hour 2014 traffic volumes for each off-ramp and the corresponding volume on the mainline at that time. The table is formatted like Table 2-2. For some locations, traffic volumes are shown for two distinct conditions:

- *30th High Ramp*. This depicts conditions on both the off-ramp and on the mainline when the **ramp** volume is at its 30th highest hour.
- *30th High ML*. This depicts conditions on both the off-ramp and on the mainline with the **mainline** volume is at its 30th highest hour.

In some instances, only the "30th High ML" condition is shown. In those instances, the ramps and the mainline segments peak at the same time periods and a 30th high mainline scenario would be similar to the 30th high ramp scenario.

Table 3-4– 2014 Volumes at Diverge Sections

Location	Exit #	Segment	NB-Off 30th High Ramp	NB-Off 30th High ML	SB-Off 30th High Ramp	SB-Off 30th High ML
Kittery	Exit 1	Ramp ML*	N/A	300 5,146	N/A	
Kittery	Exit 2	Ramp ML	N/A	435 4,846	N/A	460 4,335
Kittery	Exit 3	Ramp ML	N/A	946 4,411	N/A	
York	Exit 7	Ramp ML	N/A	984 4,288	N/A	402 3,769
Wells	Exit 19	Ramp ML	N/A	635 3,706	443 2,248	275 3,641
Kennebunk	Exit 25	Ramp ML	N/A	273 3,553	495 2,531	267 3,334
Biddeford	Exit 32	Ramp ML	311 2,776	265 3,320	N/A	1,430 3,842
Saco	Exit 36	Ramp ML	661 3,569	603 3,910	N/A	1,258 4,180
Scarborough	Exit 42	Ramp ML	379 3,293	334 3,996	N/A	325 4,100
I-295	Exit 44	Ramp ML	1,396 3,661	1,063 3,919	N/A	
South Portland	Exit 45	Ramp ML	N/A	1,074 2,798	753 1,896	534 2,598
Jetport	Exit 46	Ramp ML	611 2,234	222 2,473	N/A	970 2,754
Rand Road	Exit 47	Ramp ML	N/A	403 3,081	N/A	160 2,577
Riverside	Exit 48	Ramp ML	N/A	647 2,894	N/A	477 2,374
Falmouth	Exit 52	Ramp ML	N/A	449 2,677	N/A	262 2,019
West Falmouth	Exit 53	Ramp ML	N/A	647 2,246	N/A	302 1,790
Gray	Exit 63	Ramp ML	N/A	885 1,778	224 910	181 972
Auburn	Exit 75	Ramp ML	N/A	511 1,089	N/A	449 954
Lewiston	Exit 80	Ramp ML	N/A	466 1,035	254 643	104 722

Note: ML indicates Mainline.

HNTB input the volumes in Table 2-4, along with all appropriate geometric and other traffic-related parameters, into the Highway Capacity Software (HCS). The existing LOS estimates generated by HCS are documented in Table 2-5.

Table 3-5 – 2014 LOS at Diverge Sections

Location	Exit #	NB-Off		SB-Off	
		30th High Ramp	30th High ML	30th High Ramp	30th High ML
Kittery	Exit 1	N/A	D	N/A	
Kittery	Exit 2	N/A	D	N/A	D
Kittery	Exit 3	N/A	D	N/A	
York	Exit 7	N/A	D	N/A	D
Wells	Exit 19	N/A	C	B	C
Kennebunk	Exit 25	N/A	B	B	C
Biddeford	Exit 32	C	C	N/A	D*
Saco	Exit 36	C	C	N/A	D*
Scarborough	Exit 42	C	D	N/A	D
I-295	Exit 44	N/A	C	N/A	
South Portland	Exit 45	N/A	D	B	C
Jetport	Exit 46	C	C	N/A	D*
Rand Road	Exit 47	N/A	D	N/A	C
Riverside	Exit 48	N/A	C	N/A	C
Falmouth	Exit 52	N/A	C	N/A	B
West Falmouth	Exit 53	N/A	B	N/A	B
Gray	Exit 63	N/A	B	A	A
Auburn	Exit 75	N/A	A	N/A	A
Lewiston	Exit 80	N/A	A	A	A

*LOS reflects conditions at the diverge without influence from downstream intersections. At these locations, traffic operations at downstream signals have been observed to impact the operations.

SUMMARY OF FINDINGS

The results of the diverge analysis are similar to the results of the merge analysis (as documented in Table 2-3). All locations operate at LOS D or better under existing conditions. Moreover, it appears that the "30th High ML" condition is the controlling condition at virtually every location.

3.4.4 Mainline Travel Sections

The mainline travel sections were analyzed according to the methods of the Highway Capacity Manual, which refers to the sections of a limited access facility as freeway sections. A basic freeway segment is defined as a length of a limited access roadway whose operations are unaffected by weaving, diverging or merging. According to the Highway Capacity methodology, the area of influence for a diverge segment and merge segment is 1,500 feet upstream of the gore and 1,500 feet downstream of the gore, respectively. So, the basic freeway segment is outside of any weaving areas and the influence areas for merge and diverge operations. These occur between all interchanges along the roadway.

The parameters affecting this analysis are lane geometry, free-flow speed, an adjustment factor for driver's familiarity with the roadway, and the peak 15 minute volume. In this analysis, the design hour traffic volume was calculated for the 30th highest hour from the year 2014 data and a peak hour factor of 0.95 was used to compute the peak 15 minute volume. Table 2-6 shows the design hour volumes and the level of service for all of the mainline sections of the Turnpike.

Table 3-6 – 2014 Volumes and LOS for Mainline Sections

Segment	NB Mainline		SB Mainline	
	Vol.	LOS	Vol.	LOS
0 to 1	4,965	**E**	5,146	**E**[1]
1 to 2	4,757	**E**	4,846	**E**[1]
2 to 7	4,335	**D**	4,288	**D**
7 to 19	3,769	**C**	3,706	**C**
19 to 25	3,641	**C**	3,553	**C**
25 to 32	3,334	**C**	3,320	**C**
32 to 36	3,842	**C**	3,910	**C**
36 to 42	4,180	**D**	3,996	**C**
42 to 44	4,100	**D**	3,919	**C**
44 to 45	2,720	**D**	2,798	**D**
45 to 46	2,598	**D**	2,473	**D**
46 to 47	2,754	**D**[2]	3,081	**D**
47 to 48	2,577	**D**	2,894	**D**
48 to 52	2,374	**C**	2,677	**D**
52 to 53	2,019	**C**	2,246	**C**
53 to 63	1,778	**B**	1,790	**C**
63 to 75	1,089	**A**	972	**A**
75 to 80	1,035	**A**	954	**A**

[1]These segments regularly see queuing from the lower capacity Piscataqua River Bridge.
[2]In 2015, this segment operates at a LOS E

SUMMARY OF FINDINGS

All sections of mainline are operating at or above the desired levels of service, with the exception of the stretch of Turnpike in Kittery between the Piscataqua River Bridge and Exit 2. These are the most heavily-traveled 3 lane sections on the Turnpike. Traffic between Exits 1-7 is constrained by the Piscataqua River Bridge, whose practical capacity is estimated by HNTB to be in the range of 5200-5300 vph. By comparison, the capacity of the three lane section of the Turnpike has been measured at 5400 vph. It should be noted that, the northbound and southbound direction on the Piscataqua River Bridge currently operate at a LOS F. So, the northbound direction on the Turnpike will operate at LOS E because the bridge restricts the flow of traffic onto the Turnpike. In the southbound direction queues spill back onto the Turnpike from the bridge. In the near future, it will be necessary for the Authority to coordinate with the Maine Department of Transportation and the New Hampshire Department of Transportation who jointly own the bridge concerning how to address the capacity constraint of the Piscataqua River Bridge.

3.4.5 Summary – Existing Level of Service Analysis

Overall the majority of the Maine Turnpike is currently functioning at acceptable Levels of Service.

- All merge segments meet or exceed the LOS grade of D which provides acceptable operating conditions.

- All diverge segments meet or exceed the LOS grade of D which provides acceptable operating conditions.
- Four mainline segments (all of which were located south of Exit 2 in Kittery) received a grade of E which is characterized by significant delays and average travel speeds of 33% or less of the free flow speed. All other segments fell in or above the desired level of service.
- All of the Portland area roadway segments between Exits 44 and 48 operated at a LOS D in 2014. **The segment between Exits 46-47 northbound was operating at LOS E in 2015.** These segments should be monitored carefully moving forward as the other sections approach LOS E, which is undesirable.
- Because of the limitations of HCM and the low level-of-service in the Portland area, an additional, more detailed analysis was done of the Portland area and is discussed in Section 4.

4 FUTURE CONDITIONS

Future traffic volumes on the Maine Turnpike were calculated using a fixed annual growth rate. Forecasted 10 and 20 year volumes were compounded annually using the 2014 data as base volumes. The following sections detail the calculations and assumptions used to establish the growth rate and show the forecasted volumes and corresponding levels of service.

Other projects and developments (such as the Gorham East-West Corridor Study) may have an impact on future traffic, but those impacts are not yet determined. This Study and potential developments are discussed further in Sections 6.

4.1 Growth Rate Calculations

In order to calculate the forecasted traffic volumes in 10 and 20 years, a peak hour growth rate was determined. One method to predict future traffic growth is to look at historic traffic growth and apply the historic growth rate to current peak hour traffic to develop future traffic volumes.

HNTB gathered hourly data on entering traffic from all toll plazas within the Safety and Capacity study area – from York to Exit 63 and the New Gloucester Toll Plaza for 2005 and 2014-2015 (which includes data from July 2015). The average annual growth for the different regions of this section of the Turnpike varies from 0-1.6%, with the region north of West Falmouth seeing no growth and the Biddeford to Scarborough region seeing the highest growth. The growth rate for the region north of West Falmouth was likely impacted by the recent toll increases at the New Gloucester Toll Plaza. For that reason, the growth rate north of West Falmouth was held at the same growth rate as the previous Safety and Capacity Study. The growth rates used for this study are summarized in Table 3-1. A detailed explanation of how the growth rates for the section of Turnpike south of West Falmouth were developed can be found in Appendix E.

Table 4-1 – Annual Peak Hour Growth Assumptions

Region	Annual Growth Rate
Piscataqua River Bridge to the York Toll Plaza (Exit 7)	0.5%
York Toll Plaza (Exit 7) to Biddeford (Exit 32)	1.5%
Biddeford (Exit 32) to Scarborough (Exit 42)	1.6%
Scarborough (Exit 42) to W. Falmouth (Exit 53)	1.5%
W. Falmouth (Exit 53) to Lewiston (Exit 80	1.1%

4.2 Interchange Merge Sections

A forecasted timeline was established for each merge section regarding when it is expected to receive a Level of Service rating of E and F. LOS E indicates that the section of roadway is at capacity. At LOS E small interruptions in traffic flow can cause traffic congestion. LOS E, therefore, is a good indicator that improvements will need to be made in the near future and the permitting process should begin. The year that a merge section is forecasted to reach LOS F is a desirable time to begin construction. Table 3-2 illustrates this timeline. LOS values in Table 3-2 are based on predicted volumes from the 'worst case scenario' presented in Section 2.4.2. In most cases, the worst case scenario was associated with merge conditions during the 30th highest hour on the mainline. The volumes used, as well as a table presenting the 10 and 20 year forecasted levels-of-service, can be found in Appendix C.

There are a few important trends to note about Table 3-2:

- The merge areas at Exits 1 SB and 2 SB will approach capacity within the next 20 years.
- All interchanges between Exits 32 and 48 will have one or more ramps that will approach capacity during the next 20 years.
- There are four merge areas that will approach capacity during the next decade. These include the Exit 36 NB on-ramp, the Exit 44 SB on-ramp, the Exit 46 NB on-ramp, and the Exit 47 NB on-ramp.
- Most merge areas will not reach capacity within the 20 year scope.
- At eight interchanges (Exits 7, 19, 25, 52, 53, 63, 75, and 80), HNTB does not forecast any merge-related constraints.

Table 4-2 – Year When Merge Areas Reach LOS E and F

Exit #	Location	Ramp	Year of LOS E	Year of LOS F
Exit 1	Kittery	SB-On	2028	Beyond 2034
Exit 2	Kittery	NB-On	Beyond 2034	Beyond 2034
		SB-On	2014	Beyond 2034
Exit 7	York	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 19	Wells	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 25	Kennebunk	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 32	Biddeford	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 36	Saco	NB-On	2026	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 42	Scarborough	NB-On	Beyond 2034	Beyond 2034
		SB-On	2029	Beyond 2034
Exit 44	I-295	SB-On	Beyond 2034	Beyond 2034
Exit 45	Maine Mall Road (South Portland)	NB-On	Beyond 2034	Beyond 2034
		SB-On	2033	2034
Exit 46	Jetport (Portland)	NB-On	2024	2026
		SB-On	Beyond 2034	Beyond 2034
Exit 47	Rand Road (Portland)	NB-On	2030	2031
		SB-On	2026	2033
Exit 48	Riverside (Portland)	NB-On	2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 52	Falmouth	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 53	West Falmouth	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 63	Gray	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 75	Auburn	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034
Exit 80	Lewiston	NB-On	Beyond 2034	Beyond 2034
		SB-On	Beyond 2034	Beyond 2034

A merge segment reaches its capacity based on traffic volumes of the ramp and the mainline segment. A large amount of traffic on either the mainline or the ramp could cause the merge area to reach its capacity. For example, the Exit 47 SB on-ramp merge area reaches capacity in 2026 due to the large traffic volume on the mainline link between Exits 46-47.

The preceding analysis looked at the capacity of the *merge area*—that is, the region at which traffic from an on-ramp merges with traffic on the mainline. However, it is possible that a particular ramp will reach its capacity before the ramp's subsequent merge area does. This is particularly true for busy single-lane ramps. In these cases, widening the segment that is operating at capacity will generally prevent the predicted merge area failure.

A timeline displaying the estimated year for each on-ramp to reach capacity is shown in Table 3-3. The assessment was based on the assumption that ramps have an effective capacity of 1,650 vehicles per lane per hour. This assumption is based on engineering judgment; at present, there is no pre-defined method for calculating LOS for ramp segments.

Table 4-3 –Year When On-Ramps Reach Capacity

Exit #	Location	Ramp	Current Volume	Number of Lanes	Ramp Capacity	Year Expected to Reach Capacity
Exit 1	Kittery	SB-On	208	1	1,650	Beyond 2034
Exit 2	Kittery	NB-On	679	1	1,650	Beyond 2034
		SB-On	1,449	1	1,650	Beyond 2034
Exit 7	York	NB-On	318	1	1,650	Beyond 2034
		SB-On	1,008	1	1,650	Beyond 2034
Exit 19	Wells	NB-On	504	1	1,650	Beyond 2034
		SB-On	503	1	1,650	Beyond 2034
Exit 25	Kennebunk	NB-On	534	1	1,650	Beyond 2034
		SB-On	254	1	1,650	Beyond 2034
Exit 32	Biddeford	NB-On	1,373	1	1,650	2026
		SB-On	251	1	1,650	Beyond 2034
Exit 36	Saco	NB-On	1,455	1	1,650	2022
		SB-On	725	1	1,650	Beyond 2034
Exit 42	Scarborough	NB-On	292	1	1,650	Beyond 2034
		SB-On	409	1	1,650	Beyond 2034
Exit 44	I-295	SB-On	1,646	1*	1,650	2015
Exit 45	South Portland	NB-On	763	1	1,650	Beyond 2034
		SB-On	684	1	1,650	Beyond 2034
Exit 46	Jetport	NB-On	909	1	1,650	Beyond 2034
		SB-On	504	1	1,650	Beyond 2034
Exit 47	Rand Road	NB-On	211	1	1,650	Beyond 2034
		SB-On	350	1	1,650	Beyond 2034
Exit 48	Riverside	NB-On	494	1	1,650	Beyond 2034
		SB-On	610	1	1,650	Beyond 2034
Exit 52	Falmouth Spur	NB-On	234	1	1,650	Beyond 2034
		SB-On	664	1	1,650	Beyond 2034
Exit 53	West Falmouth	NB-On	271	1	1,650	Beyond 2034
		SB-On	723	1	1,650	Beyond 2034
Exit 63	Gray	NB-On	231	1	1,650	Beyond 2034
		SB-On	969	1	1,650	Beyond 2034
Exit 75	Auburn	NB-On	477	1	1,650	Beyond 2034
		SB-On	463	1	1,650	Beyond 2034
Exit 80	Lewiston	NB-On	200	1	1,650	Beyond 2034
		SB-On	506	1	1,650	Beyond 2034

*Exit 44 SB on-ramp is a two-lane ramp that becomes one lane before the merge with the Turnpike. It therefore effectively acts as a one lane ramp.

Table 3-3 suggests that three on-ramps are expected to reach capacity within 20 years:

- Exit 32 – Biddeford – Northbound
- Exit 36 – Saco – Northbound
- Exit 44 – I-295 – Southbound

The Exit 2 SB on-ramp currently has a heavy volume (1,449 vph), and it would normally be expected to exceed the capacity of a single-lane ramp within a few years. The Exit 36 NB on-ramp has a very similar volume (1,455 vph), and it is expected to reach its capacity by 2022. However, as noted in Section 3.1, the study assumed that the peak-hour growth rate south of York will be muted (at an estimated 0.5% annual growth) because of the capacity constraint imposed by the Piscataqua River Bridge. The low growth rate prevents the Exit 2 SB on-ramp from reaching its capacity over the next 20 years.

4.3 Interchange Diverge Sections

A forecasted timeline was established for each diverge section regarding when it is expected to receive a Level of Service rating of E and F. LOS E indicates that the section of roadway is at capacity. At LOS E small interruptions in traffic flow can cause traffic congestion. LOS E, therefore, is a good indicator that improvements will need to be made in the near future and the permitting process should begin. The year that a diverge section is forecasted to reach LOS F is a desirable time to begin construction. Table 3-4 illustrates this timeline. LOS values are based on predicted volumes from the 'worst case scenario' presented in Section 2.4.3. The volumes used as well as a table presenting the 10 and 20 year forecasted Levels of Service can be found in Appendix C.

Table 4-4 – Year When Diverge Areas Reach LOS E and F

Exit #	Location	Ramp	Year of LOS E	Year of LOS F
Exit 1	Kittery	NB-Off	2026	2027
Exit 2	Kittery	NB-Off	2025	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 3	Kittery	NB-Off	2030	Beyond 2034
Exit 7	York	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	2030	Beyond 2034
Exit 19	Wells	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 25	Kennebunk	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 32	Biddeford	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	2020	2021
Exit 36	Saco	NB-Off	2022	2023
		SB-Off	2020	2030
Exit 42	Scarborough	NB-Off	2032	Beyond 2034
		SB-Off	2028	Beyond 2034
Exit 44	I-295 (South Portland)	NB-Off	Beyond 2034	Beyond 2034
Exit 45	Maine Mall Road (South Portland)	NB-Off	2021	2032
		SB-Off	Beyond 2034	Beyond 2034
Exit 46	Jetport (Portland)	NB-Off	2031	Beyond 2034
		SB-Off	2027	2033
Exit 47	Rand Road (Portland)	NB-Off	2017	2026
		SB-Off	2032	Beyond 2034
Exit 48	Riverside (Portland)	NB-Off	2029	2030
		SB-Off	Beyond 2034	Beyond 2034
Exit 52	Falmouth	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 53	West Falmouth	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 63	Gray	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 75	Auburn	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034
Exit 80	Lewiston	NB-Off	Beyond 2034	Beyond 2034
		SB-Off	Beyond 2034	Beyond 2034

Table 3-4 illustrates the diverge areas that will receive a Level of Service rating of E or F within the next 20 years. A few important trends to note:

- Only 6 interchanges (Wells, Kennebunk, W. Falmouth, Gray, Auburn, and Lewiston) are expected to be completely free of diverge-related capacity constraints. All other interchanges in the study area are expected to have at least one diverge area that reaches its capacity over the next 20 years.
- Three locations are expected to have a diverge area reach its capacity (i.e. LOS E) by 2020. These locations include:

    - Exit 32 SB off-ramp (2020)
    - Exit 36 SB off-ramp (2020)
    - Exit 47 NB off-ramp (2017)
- Two locations are expected to have a diverge area that *exceeds* its capacity (i.e. LOS F) within the next decade. These locations include:
    - Exit 32 SB off-ramp (2021)
    - Exit 36 NB off-ramp (2023)

A diverge segment reaches its capacity based on traffic volumes of the ramp and the mainline segment. A large amount of traffic on either the mainline or the ramp could cause the diverge area to reach its capacity. For example, the Exit 47 NB off-ramp diverge area reaches capacity in 2017 due to the large traffic volume on the mainline link between Exits 46-47.

It is possible for either a mainline segment or a ramp segment to reach capacity before the ramp's diverge area does. In these cases widening of the segment that is operating at capacity will prevent the predicted diverge area failure. A timeline displaying the estimated year for each off-ramp segment to reach capacity is shown in Table 3-5.

In reviewing the results documented in Table 3-5, it is important to note that the ramp segments were assessed in a different manner than the diverge areas. As noted above, the Highway Capacity Software has an established methodology for analyzing diverge areas. However, there is no method for calculating the LOS for the ramp segment itself. Therefore, all off-ramps were assumed to have a fixed capacity of 1,650 vehicles per lane per hour. This is the same value that was used for the on-ramp capacity analysis (see Section 3.2), based on engineering judgment and repeated observation of traffic conditions on Maine Turnpike ramps.

Table 4-5 – Year when Off-Ramps Reach Capacity

Exit #	Location	Ramp	Current Volume	Number of Lanes	Ramp Capacity	Year when Expected to Reach Capacity
Exit 1	Kittery	NB-Off	300	1	1,650	Beyond 2034
Exit 2	Kittery	NB-Off	435	1	1,650	Beyond 2034
		SB-Off	460	1	1,650	Beyond 2034
Exit 3	Kittery	NB-Off	855	1	1,650	Beyond 2034
Exit 7	York	NB-Off	984	1	1,650	Beyond 2034
		SB-Off	402	1	1,650	Beyond 2034
Exit 19	Wells	NB-Off	635	1	1,650	Beyond 2034
		SB-Off	443	1	1,650	Beyond 2034
Exit 25	Kennebunk	NB-Off	273	1	1,650	Beyond 2034
		SB-Off	495	1	1,650	Beyond 2034
Exit 32	Biddeford	NB-Off	311	1	1,650	Beyond 2034
		SB-Off	1,430	1	1,650	2024
Exit 36	Saco	NB-Off	661	1	1,650	Beyond 2034
		SB-Off	1,258	1	1,650	2032
Exit 42	Scarborough	NB-Off	379	1	1,650	Beyond 2034
		SB-Off	325	1	1,650	Beyond 2034
Exit 44	I-295	NB-Off	1,396	2	3,300	Beyond 2034
Exit 45	South Portland	NB-Off	1,074	1	1,650	Beyond 2034
		SB-Off	753	1	1,650	Beyond 2034
Exit 46	Jetport	NB-Off	611	1	1,650	Beyond 2034
		SB-Off	970	1	1,650	Beyond 2034
Exit 47	Rand Road	NB-Off	403	1	1,650	Beyond 2034
		SB-Off	160	1	1,650	Beyond 2034
Exit 48	Riverside	NB-Off	647	1	1,650	Beyond 2034
		SB-Off	477	1	1,650	Beyond 2034
Exit 52	Falmouth Spur	NB-Off	449	1	1,650	Beyond 2034
		SB-Off	262	1	1,650	Beyond 2034
Exit 53	West Falmouth	NB-Off	647	1	1,650	Beyond 2034
		SB-Off	302	1	1,650	Beyond 2034
Exit 63	Gray	NB-Off	885	1	1,650	Beyond 2034
		SB-Off	224	1	1,650	Beyond 2034
Exit 75	Auburn	NB-Off	511	1	1,650	Beyond 2034
		SB-Off	449	1	1,650	Beyond 2034
Exit 80	Lewiston	NB-Off	466	1	1,650	Beyond 2034
		SB-Off	254	1	1,650	Beyond 2034

Only two off-ramps are expected to reach capacity in the next 20 years: the southbound off-ramps at Exit 32 (Biddeford) and Exit 36 (Saco). These two ramps and associated merge areas will clearly need attention in the years to come.

4.4 Mainline Sections

LOS values are based on predicted mainline volumes from Section 2.4.4. A forecasted timeline was established for each mainline section regarding when it is expected to receive a Level of Service rating of E and F. LOS E is a good indicator that improvements will need to be made in the near future and the permitting process should begin. It is desirable to begin construction before a mainline section reaches LOS F to avoid unreasonable delays and situations which could compromise safety.

Table 3-6 summarizes the calendar years during which each segment is anticipated to be servicing a volume high enough to produce a LOS rating of E and F. In some instances (e.g. between Exits 0 and 2 in Kittery, in both directions), the facility has already been operating at LOS E during peak times. The volumes used as well as a table presenting the 10 and 20 year forecasted Levels of Service can be found in Appendix C.

Table 4-6 - Year When Mainline Segments Reach LOS E and F

Link	Location	NB Mainline		SB Mainline	
		LOS E	LOS F	LOS E	LOS F
0-1	NH Border to Kittery Exit 1*	2008	2025	2011	2032
1-2	Kittery Exit 1 to 2*	2012	Beyond 2034	2013	Beyond 2034
2-7	Kittery to York*	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034
7-19	York to Wells	2034	Beyond 2034	2033	Beyond 2034
19-25	Wells to Kennebunk	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034
25-32	Kennebunk to Biddeford	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034
32-36	Biddeford to Saco	2029	Beyond 2034	2030	Beyond 2034
36-42	Saco to Scarborough	2028	Beyond 2034	2025	2033
42-44	Scarborough to I-295	2030	Beyond 2034	2027	Beyond 2034
44-45	I-295 to Maine Mall Rd.	2022	2031	2024	2033
45-46	Maine Mall Rd. to Jetport	2030	Beyond 2034	2027	Beyond 2034
46-47	Jetport to Rand Rd.	2015	2025	2023	2032
47-48	Rand Rd. to Riverside	2020	2029	2027	Beyond 2034
48-52	Riverside to Falmouth	2025	2034	2033	Beyond 2034
52-53	Falmouth to West Falmouth	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034
53-63	West Falmouth to Gray	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034
63-75	Gray to Auburn	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034
75-80	Auburn to Lewiston	Beyond 2034	Beyond 2034	Beyond 2034	Beyond 2034

* Traffic between Exits 1-7 is constrained by the Piscataqua River Bridge, whose practical capacity is estimated to be 5200 vph. By comparison, the capacity of the three lane section of the Turnpike has been measured at 5400 vph. So, the northbound direction on the Turnpike will operate at LOS E because the bridge restricts the flow of traffic onto the Turnpike. In the southbound direction queues spill back onto the Turnpike from the bridge. In the near future, it will be necessary for the Authority to coordinate with the Maine Department of Transportation and the New Hampshire Department of Transportation concerning how to address the capacity constraint of the Piscataqua River Bridge.

Table 3-6 illustrates which mainline sections of the Turnpike will receive a LOS grade of E or F due to capacity within the next 20 years. Below is a summary of when capacity improvements will be needed in order to avoid LOS E or F conditions:

- Within 10 years (2024 or earlier):
  - Miles 0-2 between the New Hampshire state line and Kittery
  - Miles 44-48 (most sections)
- Within 20 years (2025-2034)
  - Miles 32-44 (This 3-lane section will be on the verge of requiring a 4th lane.)
  - Miles 48-52

No capacity improvements will be needed north of Exit 52 for the foreseeable future.

In sum, the required capacity improvements are clustered in two locations.

- The first general location is the southernmost portion of the Turnpike between the New Hampshire border and Kittery. This is the most heavily-traveled portion of interstate in the entire state of Maine. Within the next 20 years, this section ought to be widened to 4 lanes (from its current width of 3 lanes). However, the effectiveness of such a widening is going to be constrained by the fact that the Piscataqua River Bridge only carries 3 lanes in either direction.
- The second general location is the portion of the Turnpike between Biddeford and South Portland, which was expanded to 3 lanes in the previous Widening (2000-2004). As commuting volumes continue to climb, the section may need a 4th lane toward the end of the study period.
- The third general location is the 2-lane section of the Turnpike between Exit 44 and Exit 52. The two most critical segments are (a) between Exits 44 and 45, and (b) between Exits 46 and 47. These locations will be examined more closely in Section 4.

4.5 Summary of Future Conditions

Table 3-7 and Table 3-8 each present a year-by-year summary of when each interchange, mainline, and ramp on the Turnpike is forecasted to reach LOS E and LOS F. The evaluated areas include on- and off-ramps, diverge and merge areas, and mainline segments. A particular portion of the system should be considered for improvements when it hits LOS E.

Table 4-7 – Areas between Kittery & Exit 44 Reaching LOS E and F, 2015-2034

Physical Location	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
NH Border to Exit 1 (Kittery)	*NB ML, SB ML*										NB ML						SB ML			
Exit 1 - Dennett Road				*NB-off Diverge Area*	*SB-on Merge Area*								NB-Off Diverge Area							
Exit 1 to Exit 2 (Kittery)	*NB ML, SB ML*																			
Exit 2 - Kittery	*SB-on Merge Area*			*NB-off Diverge Area*								*SB-off Diverge Area*								
Exit 3 – Kittery						*NB-off Diverge Area*										*NB-on Merge Area*				
Kittery to York (2/3-7)																				
York Exit 7						*NB-off Diverge Area*										*SB-off Diverge Area*				
York to Wells (7-19)																			*SB ML*	*NB ML*
Wells Exit 19																				
Wells to Kennebunk (19-25)																				
Kennebunk Exit 25																				
Kennebunk to Biddeford (25-32)																				
Biddeford Exit 32						*SB-off Diverge Area*	SB-Off Diverge Area			SB-Off Ramp		NB-On Ramp								
Biddeford to Saco (32-36)															*NB ML*	*SB ML*				
Saco Exit 36						*SB-off Diverge Area*		*NB-off Diverge Area*, NB-On Ramp	NB-Off Diverge Area			*NB-on Merge Area*						SB-Off Ramp		
Saco to Scarborough (36-42)											*SB ML*			*NB ML*					SB ML	
Scarborough Exit 42														*SB-off Diverge Area*	*SB-on Merge Area*			*NB-off Diverge Area*		
Scarborough to I-295 (42-44)													*SB ML*			*NB ML*				
I-295 Exit 44	SB-On Ramp																			

Key: SB – southbound; NB – northbound; ML – mainline; *NB ML* – LOS E; NB ML – LOS F

Table 4-8 – Areas between Exit 44 & Exit 53 Reaching LOS E and F during Years 2014-2034

Physical Location	2015	2016	2017	2018	2019	2020	2021	2022	2023	2024	2025	2026	2027	2028	2029	2030	2031	2032	2033	2034
I-295 to South Portland (44-45)								*NB ML*		*SB ML*							NB ML		SB ML	
South Portland Exit 45							*NB-Off Diverge Area*											NB-Off Diverge Area	*SB-on Merge Area*	SB-On Merge Area
South Portland to Jetport (45-46)													*SB ML*			*NB ML*				
Jetport Exit 46											*NB-on Merge Area*	NB-On Merge Area	*SB-Off Diverge Area*				*NB-Off Diverge Area*		SB-Off Diverge Area	
Jetport to Rand Road (46-47)	*NB ML*								*SB ML*		NB ML							SB ML		
Rand Road Exit 47			*NB-Off Diverge Area*									NB-Off Diverge Area, *SB-on Merge Area*				*NB-on Merge Area*	NB-On Merge Area	*SB-Off Diverge Area*	SB-On Merge Area	
Rand Road to Riverside (47-48)						*NB ML*							*SB ML*		NB ML					
Riverside Exit 48															*NB-Off Diverge Area*	NB-Off Diverge Area				*NB-on Merge Area*
Riverside to Falmouth (48-52)											*NB ML*								*SB ML*	NB ML
Falmouth Exit 52																				
Falmouth to West Falmouth (52-53)																				
West Falmouth Exit 53																				
West Falmouth to Gray (53-63)																				
Gray (Exit 63)																				
Gray to Auburn (63-75)																				
Auburn (Exit 75)																				
Auburn to Lewiston (75-80)																				
Lewiston (Exit 80)																				

Key: SB – southbound; NB – northbound; ML – mainline; *NB ML* – LOS E; NB ML – LOS F

As can be seen from Table 3-7 and Table 3-8, a few large project groups that may be reasonably planned together include the following:

- The southern portion of the mainline from the New Hampshire state line to Exit 7 in York will need to be widened, starting roughly in 2025. However, the fact that the Piscataqua River Bridge is only 3 lanes wide will limit the extent to which an additional lane will provide any benefit.
- The Saco and Biddeford interchanges will need some improvements on selected ramps starting in 2021. Further evaluation and discussion of the Biddeford and Saco interchanges is found in Section 5.
- The SB I-295 Exit 44 on ramp should be widened to accommodate two merging lanes as soon as practicable.
- The mainline segments between Exits 32-44 will need to be widened by 2028 to accommodate the expected traffic on those sections of the Turnpike.
- The Portland area widening, from Exit 44 (I-295) to Exit 48 (Westbrook), may need to begin in the near future to avoid capacity constraints. Further evaluation and discussion of the Portland area widening is found in Section 4. In general, for any given Turnpike segment in the Portland area, the NB side of the Turnpike will reach capacity before the SB side.

5 VISSIM Traffic Analysis for the Portland Area

The HCM sets forth a methodology to determine the level of service at which an **isolated** section of a roadway facility operates. It is a useful planning level tool to analyze individual sections of roadways as summarized in the previous sections. However, there are limitations to the HCM methodology, notably the Exit 44 ramps and the ability to see how adjacent sections of closely spaced interchanges are affected by upstream or downstream impacts. Because of these limitations, an alternative analysis tool was also used to evaluate the Portland area interchanges – VISSIM.

5.1 VISSIM Analysis Methodology

VISSIM is a microscopic, time step and behavior-based traffic simulation model. It is a reliable tool to employ in order to assess complex traffic flows that involve extensive merging, diverging, and weaving. Its microsimulation capabilities enable VISSIM to help assess the extent to which changes at one location will affect adjacent interchanges. While it does not report levels-of-service, in the traditional sense, it can record measures of effectiveness such as roadway link density, which can be used in combination with LOS tables from the HCM to determine a LOS. VISSIM can also record other measures of effectiveness including queue lengths.

Queues were measured for every on-ramp at all of the Portland area interchanges. In a well-functioning ramp, no queues would develop. Therefore, the presence of a traffic queue would indicate that the merging vehicles had a great deal of difficulty finding a gap in traffic and merging, which indicates over-capacity traffic conditions.

The VISSIM models cover all of the mainline and ramps from Exit 42 through Exit 48. This includes all of the merge and diverge areas for the included interchanges. Due to the scope of this study, the model does not include the toll plazas and the adjacent intersections with the local streets.

Because of the nature of VISSIM, the models were set up according to the peak hours of the critical sections of the Turnpike and not necessarily the peak traffic times of each individual roadway link and ramp. However, most of the links and ramps in the Portland area experience peak traffic during summer weekday afternoons or fall weekday mornings. Therefore, VISSIM models were set up for a summer weekday afternoon and a fall weekday morning to capture the peak times of most of the ramps and mainline segments. They are shown in Figure 4-1 and Figure 4-2.

Figure 5-1 – AM Peak Hour Volumes in the Portland Area Balanced to Critical Link

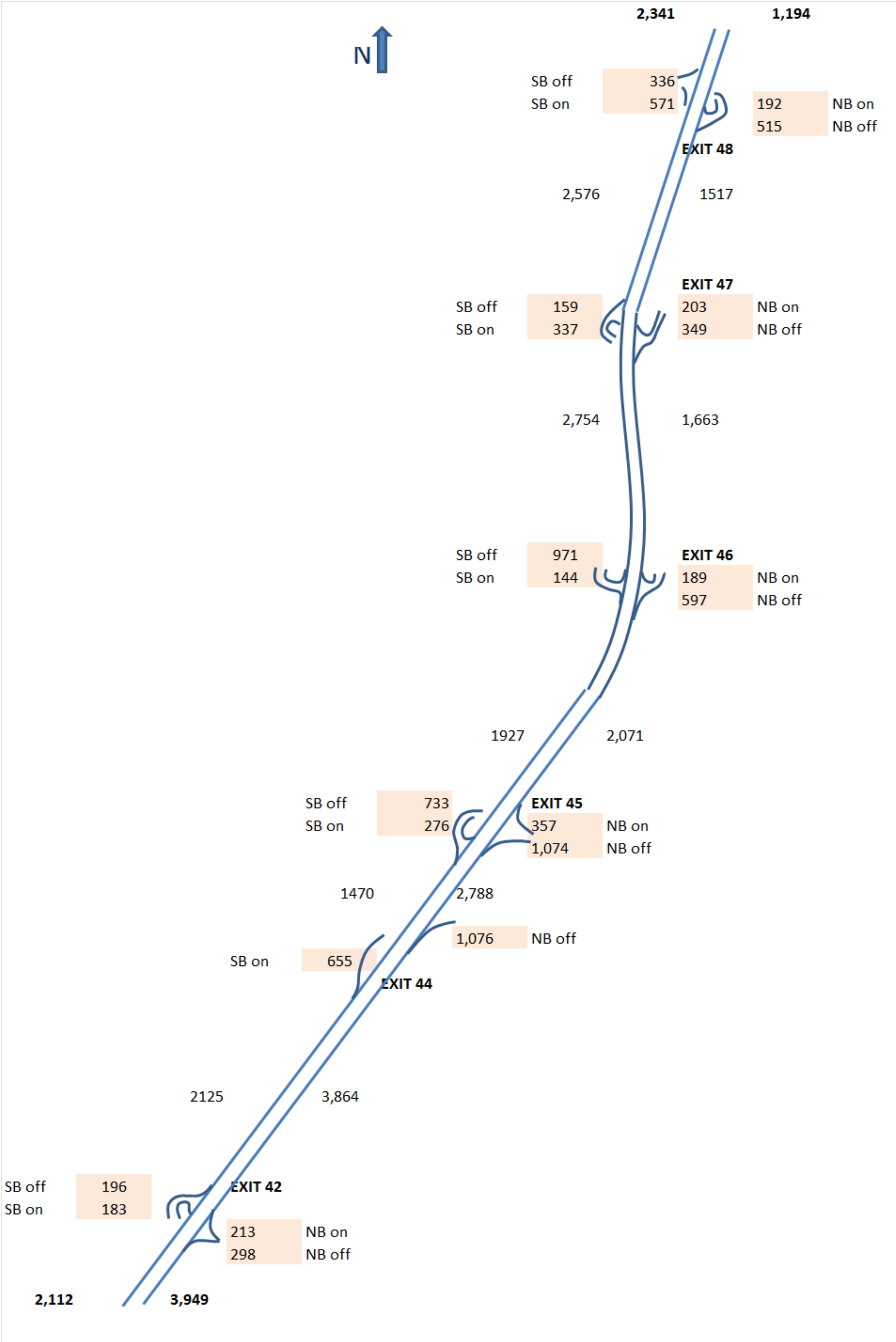
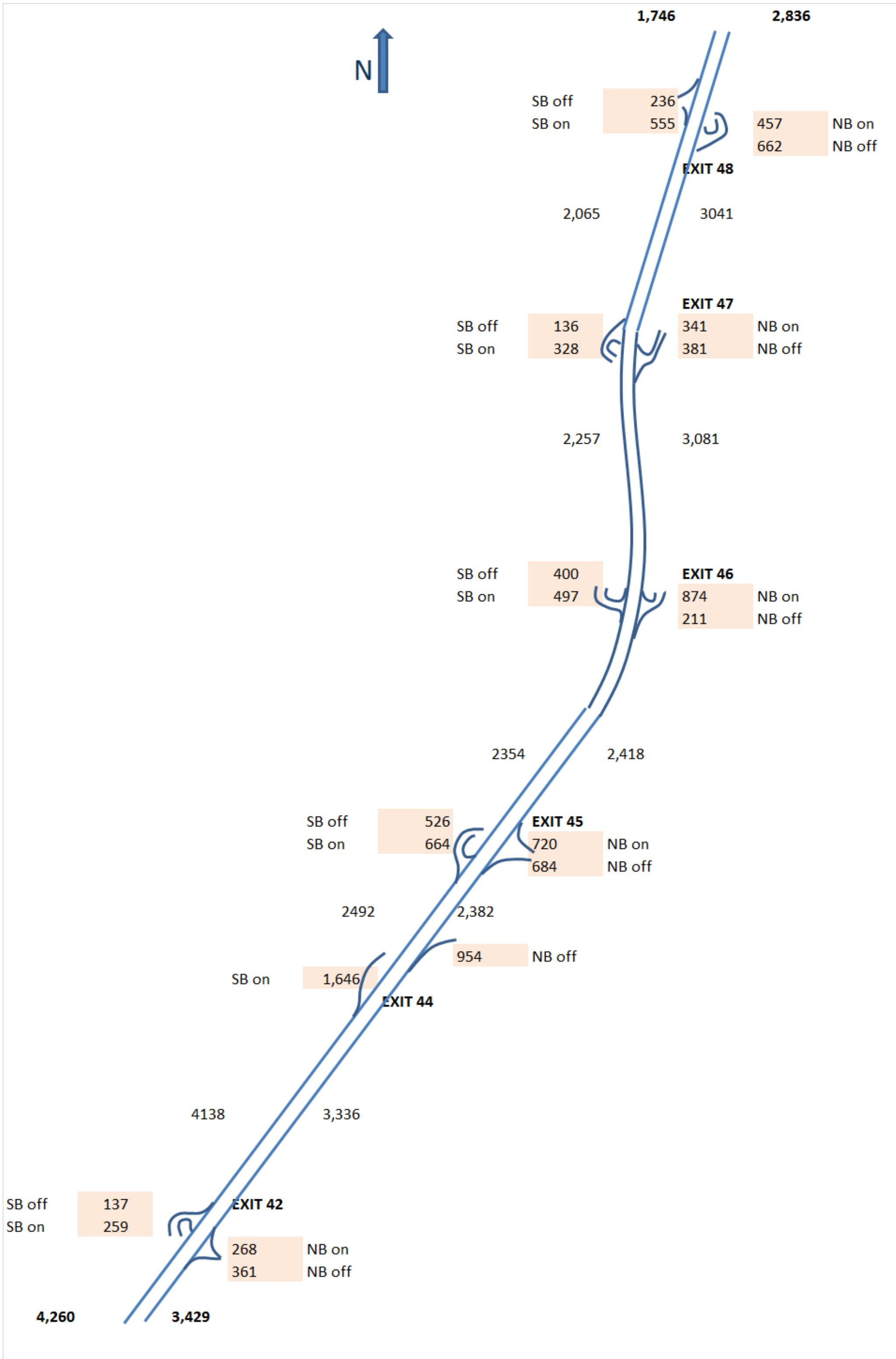


Figure 5-2 – PM Peak Hour Volumes in the Portland Area Balanced to Critical Link



5.2 2014 Traffic Analysis

The baseline traffic analysis for the Portland area provides insight into current traffic conditions and can be used to compare with future traffic conditions in the study area. The balanced critical peak hour traffic volumes were developed from the hourly traffic count data that is continuously collected by the Authority.

The baseline AM and PM peak hour traffic volumes were input into the VISSIM model and analyzed. The LOS and 95th percentile queues for each of the Portland area interchanges and mainline segments are illustrated in Table **4-1**.

As can be seen from Table **4-1**, two mainline sections, between Exits 46-47 and between Exits 47-48, operated at a LOS D during the PM peak hour in 2014. LOS D is an acceptable rating, and therefore, all mainline sections, merge and diverge areas operated at an acceptable LOS. However, the lane drop on the ramp of Exit 44 SB could cause queuing of about 200 feet even though the measured vehicle density of the two lanes of traffic indicated that the lane drop operated at a LOS C. This indicates difficulty with lane changing near the lane drop even though conventional LOS guidelines does not indicate the difficulty.

Table 5-1 – 2014 LOS & Queue Summary for the Portland Area

	AM		PM	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
42 NB off	C	--	B	--
42 NB on	B	NO	B	NO
42 SB off	B	--	C	--
42 SB on	A	NO	C	NO
44 NB off	C	--	B	--
44 SB on	B	--	C	--
45 NB off	C	--	C	--
45 NB on	B	NO	B	NO
45 SB off	B	--	B	--
45 SB on	A	NO	B	NO
46 NB off	B	--	C	--
46 NB on	B	NO	C	NO
46 SB off	B	--	B	--
46 SB on	B	NO	B	NO
47 NB off	B	--	C	--
47 NB on	B	NO	C	NO
47 SB off	B	--	B	--
47 SB on	B	NO	B	NO
48 NB off	B	--	C	--
48 NB on	A	NO	C	NO
48 SB off	B	--	B	--
48 SB on	B	NO	B	NO
42-44 NB	C	--	B	--
42-44 SB	B	--	C	--
44-45 NB	C	--	C	--
44-45 SB	B	--	B	--
45-46 NB	B	--	C	--
45-46 SB	B	--	B	--
46-47 NB	B	--	D	--
46-47 SB	C	--	B	--
47-48 NB	B	--	D	--
47-48 SB	C	--	B	--
44 ramp	A	NO	C	YES - 210

5.3 2024 Traffic Analysis

The 2014 balanced peak hour traffic volumes were increased at a rate of 1.5% per year to the design year of 2024. The estimated 2024 peak hour traffic volumes were input into the traffic capacity model and analyzed. The LOS and 95th percentile queues for each of the Portland area interchanges and mainline sections are illustrated in Table 4-2.

As can be seen from Table 4-2, the Exit 46 NB on ramp can be expected to operate at a LOS F with expected peak hour queuing of over 1,100 feet. The critical mainline sections between Exits 46-47 and between Exits 47-48 are shown to operate at a LOS E. However, the LOS E shown for those two critical sections is misleading as the LOS measurements in VISSIM depend on how well traffic moves through the system. If the traffic from Exit 46 NB were able to find gaps and merge, as a conventional HCM analysis assumes, then the traffic density would be greater and the links would function at LOS F. An improvement that would be needed to help the traffic from Exit 46 NB merge into I-95 NB traffic would be mainline widening between Exits 46-48.

The queue from the lane drop on the Exit 44 ramp is expected to grow to over 1,670 feet by 2024.

Table 5-2 – 2024 LOS and Queue Summary for the Portland Area

	AM		PM	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
42 NB off	C	--	C	--
42 NB on	C	NO	B	NO
42 SB off	B	--	C	--
42 SB on	B	NO	C	NO
44 NB off	C	--	C	--
44 SB on	B	--	C	--
45 NB off	D	--	C	--
45 NB on	B	NO	C	NO
45 SB off	B	--	B	--
45 SB on	B	NO	C	NO
46 NB off	C	--	C	--
46 NB on	B	NO	F	YES - 1,100
46 SB off	C	--	B	--
46 SB on	B	NO	B	NO
47 NB off	B	--	D	--
47 NB on	B	NO	D	NO
47 SB off	C	--	B	--
47 SB on	C	NO	B	NO
48 NB off	B	--	C	--
48 NB on	A	NO	C	NO
48 SB off	B	--	B	--
48 SB on	C	NO	B	NO
42-44 NB	C	--	C	--
42-44 SB	B	--	C	--
44-45 NB	D	--	C	--
44-45 SB	B	--	C	--
45-46 NB	C	--	C	--
45-46 SB	B	--	C	--
46-47 NB	B	--	E	--
46-47 SB	C	--	C	--
47-48 NB	B	--	E	--
47-48 SB	C	--	B	--
44 ramp	A	NO	F	YES - 1,670*

*Queues only measured to approximately 1,670 feet. Actual queue could be larger.

5.4 2034 Traffic Analysis

The 2014 balanced peak hour traffic volumes were increased at a rate of 1.5% per year to the design year of 2034. The estimated 2034 peak hour traffic volumes were input into the traffic capacity model and analyzed. The LOS and 95th percentile queues for each of the Portland area interchanges and mainline sections are illustrated in Table 4-3.

As can be seen from Table 4-3, the following on-ramps and off-ramps are expected to function at a LOS F by 2034:

- Exit 42 NB on
- Exit 45 NB on
- Exit 46 NB on
- Exit 42 NB off
- Exit 44 NB off
- Exit 46 NB off

The following mainline sections are also expected to function at a LOS F by 2034:

- Between Exits 42-44 NB
- Between Exits 45-46 NB

The following ramps are expected to have long queues (more than 200 feet) indicating that ramp traffic has difficulty finding gaps in the mainline traffic stream and is operating over-capacity. And as a consequence the traffic density, and subsequently the LOS may be under-represented at the adjacent mainline link:

- Exit 47 NB on-ramp
- Exit 42 NB on-ramp
- Exit 45 NB on-ramp
- Exit 46 NB on-ramp
- Exit 47 SB on-ramp
- Exit 48 SB on-ramp

According to the VISSIM analysis, the following mainline links will need to be widened by 2034 in order to accommodate the expected traffic.

- Between Exits 42-44 NB
- Between Exits 45-46 NB
- Between Exits 46-47 NB
- Between Exits 46-47 SB
- Between Exits 47-48 NB
- Between Exits 47-48 SB

Table 5-3 – 2034 LOS and Queue Summary for the Portland Area

	AM		PM	
Analysis Area	LOS	95th Percentile Queue (feet)	LOS	95th Percentile Queue (feet)
42 NB off	F	--	C	--
42 NB on	F	YES - 1,580	C	NO
42 SB off	B	--	C	--
42 SB on	B	NO	D	NO
44 NB off	F	--	C	--
44 SB on	B	--	D	--
45 NB off	E	--	E	--
45 NB on	C	NO	F	YES - 1,670*
45 SB off	B	--	B	--
45 SB on	B	NO	D	NO
46 NB off	C	--	F	--
46 NB on	B	NO	F	YES - 1,670*
46 SB off	D	--	C	--
46 SB on	B	NO	C	NO
47 NB off	B	--	E	--
47 NB on	B	NO	E	YES - 650
47 SB off	D	--	C	--
47 SB on	E	YES - 590	C	NO
48 NB off	B	--	C	--
48 NB on	B	NO	C	NO
48 SB off	C	--	B	--
48 SB on	D	YES - 370	B	NO
42-44 NB	F	--	C	--
42-44 SB	B	--	D	--
44-45 NB	E	--	E	--
44-45 SB	B	--	D	--
45-46 NB	C	--	F	--
45-46 SB	C	--	C	--
46-47 NB	C	--	E	--
46-47 SB	E	--	C	--
47-48 NB	B	--	E	--
47-48 SB	D	--	C	--
44 ramp	A	NO	F	YES - 1,670*

*Queues only measured to approximately 1,670 feet. Actual queue could be larger.

Even though not all links are mentioned on the above list, certain links may have traffic densities that are under-represented due to traffic congestion on an upstream link. Accordingly, some mainline links were grouped into projects so that increased traffic flow from one area to the next would not result in traffic congestion on an unimproved link. Table 4-4 shows when projects should be completed in the Portland area and how the results compare with those obtained from the HCM analysis of the previous sections.

Table 5-4 – Timeline for Portland Area Improvement Projects

Exit #/ Segment Mileage	Year from VISSIM Analysis	Year from HCM Analysis	Improvement Project
44 ramp	2016*	2016*	Ramp Merge Area Widening
46-48 NB	2023	2025	Mainline Widening
44-46 NB	2028	2031	Mainline Widening
42-44 NB	2032	beyond 2034	Mainline Widening
46-48 SB	2033	2032	Mainline Widening

* Analyses show that there is an existing traffic problem here, but improvements cannot be made before 2016.

As can be seen from Table 4-4, the VISSIM results are slightly different from the HCM results. The major reason for the differences is the nature of the analyses. HCM analyzes isolated roadway sections while VISSIM analyzes an entire area, and considers how traffic congestion impacts other areas. Another big difference from an HCM analysis and a VISSIM analysis is year at which a roadway segment becomes a LOS E. By definition, a LOS E condition reflects a traffic condition that is unstable. Since HCM is a macro-analysis tool, the traffic numbers input into the analysis will consistently result in a certain LOS. But, VISSIM is a micro-simulation analysis whose results are more varied. With unstable traffic flow, if a few vehicles stall in the traffic stream, then queues can develop and traffic density will increase even in adjacent roadway links. As a result, VISSIM does not show LOS E for a several year span as an HCS analysis would.

VISSIM has other capabilities that were not fully utilized due to the scope of this study. VISSIM can analyze proposed roadway improvements to help fine-tune them. It can evaluate differences between multiple alternatives and provide measures of effectiveness such as delays to compare alternatives.

6 VISSIM Traffic Analysis for the Biddeford/Saco Area

As mentioned in Section 4, there are limitations to the HCM methodology, notably the Exit 36 northbound off-ramp, which is adjacent to the conference center on-ramp. Because of these limitations, and the large amounts of traffic that is generated from the Biddeford and Saco interchanges, VISSIM was also used to evaluate the Biddeford/Saco interchanges.

6.1 Methodology

VISSIM is a microscopic, time step and behavior-based traffic simulation model (see Section 4 for a more comprehensive description). Because of the nature of VISSIM, the models were set up according to the peak hours of the critical sections of the Turnpike and not necessarily the peak traffic times of each individual roadway link and ramp. However, most of the links and ramps in the Biddeford/Saco region experience peak traffic during summer weekday afternoons, fall weekday mornings, or summer Friday early afternoon. Therefore, VISSIM models were set up for a summer weekday afternoon, a fall weekday morning, and a summer Friday early afternoon to capture the peak times of most of the ramps and mainline segments. They are shown in Figure 5-1, Figure 5-2, and Figure 5-3.

Queues were measured for every on-ramp at the Biddeford and Saco interchanges. In a well-functioning ramp, no queues would develop. Therefore, the presence of a traffic queue would indicate that the merging vehicles had a great deal of difficulty finding a gap in traffic and merging, which indicates over-capacity traffic conditions. Density measurements were also taken at the merge and diverge areas of all of the ramps to determine a level of service.

Figure 6-1 – AM Peak Hour Volumes in the Biddeford/Saco Area Balanced to Critical Link

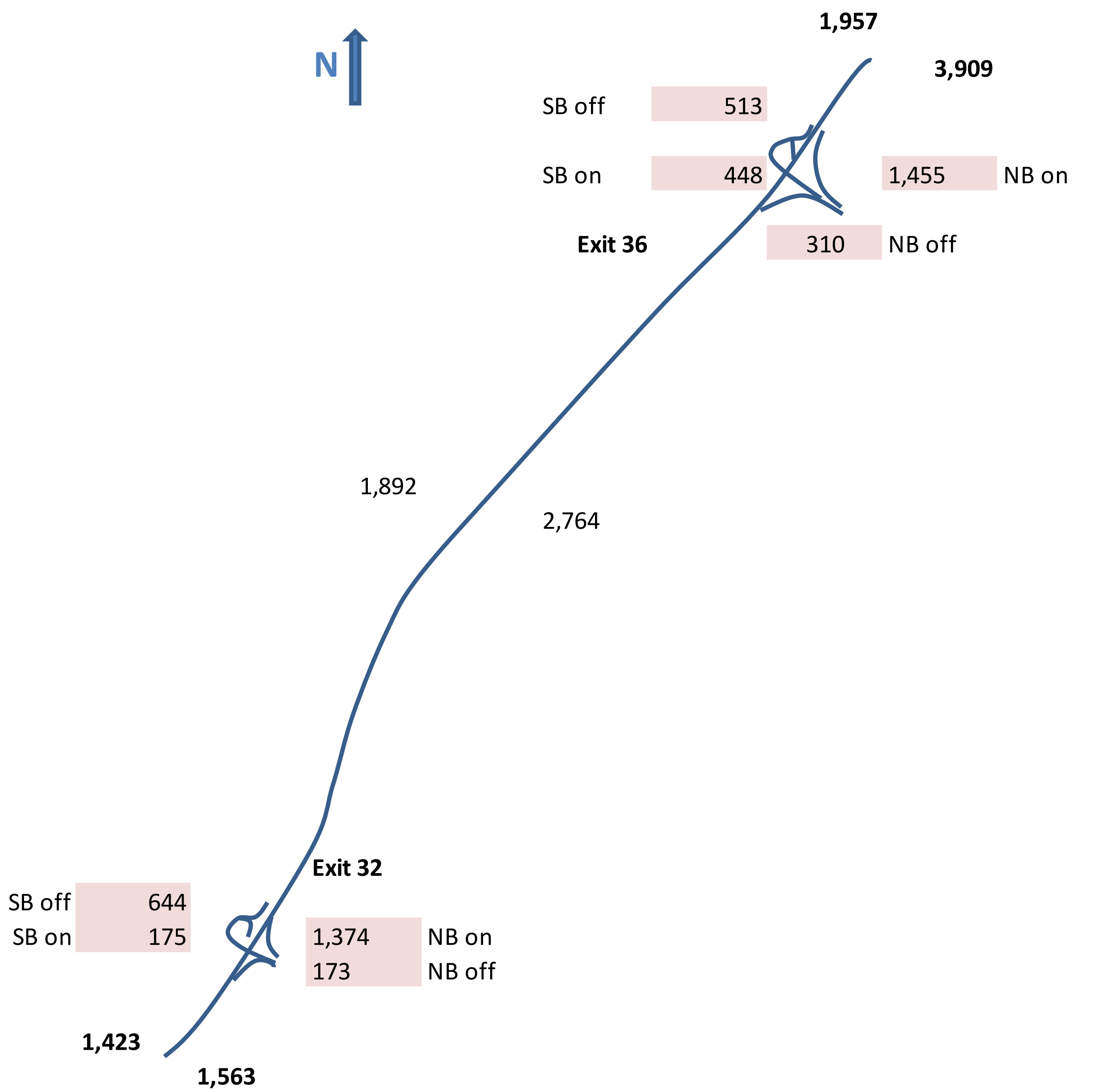


Figure 6-2 – PM Peak Hour Volumes in the Biddeford/Saco Area Balanced to Critical Link

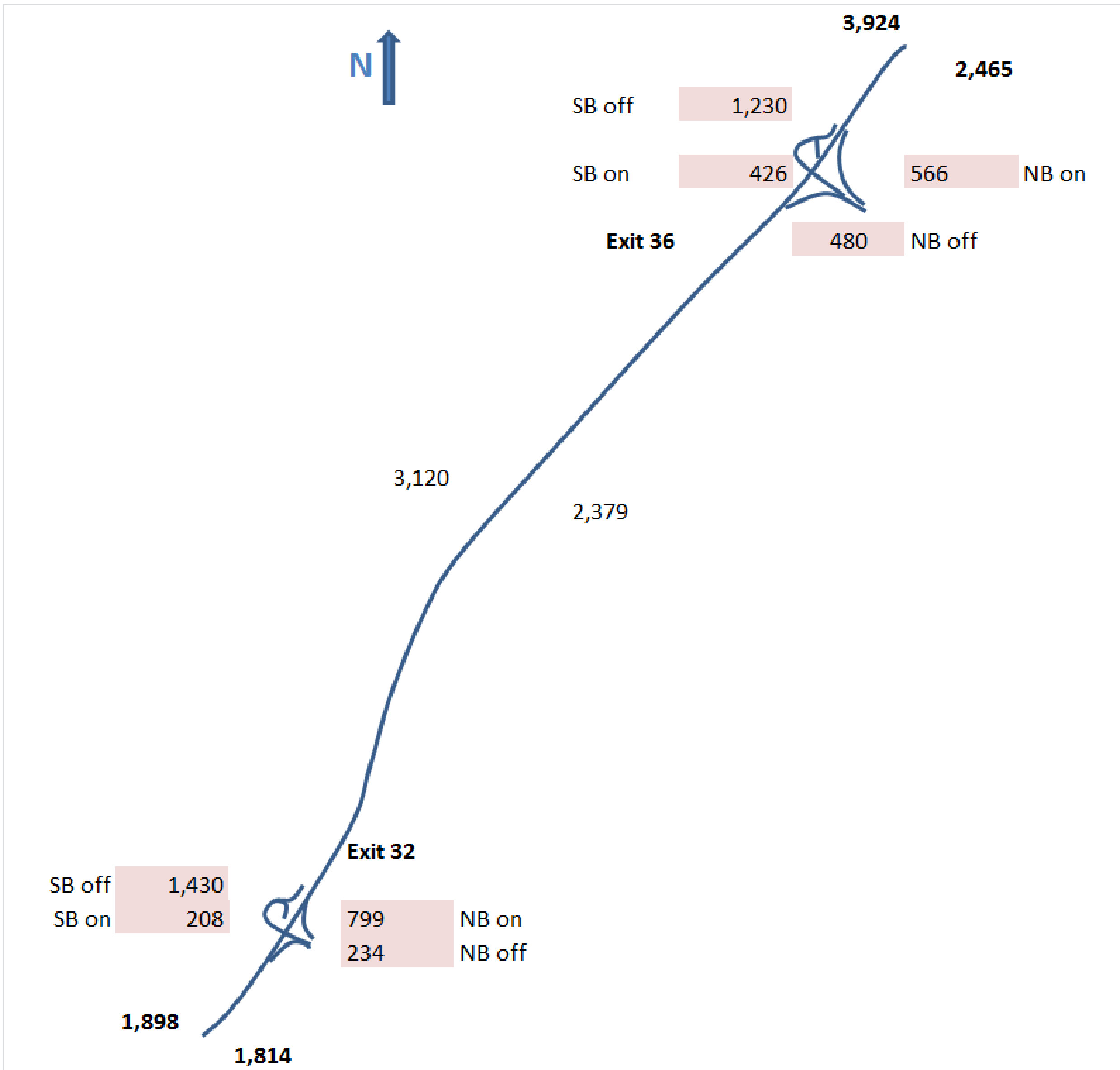
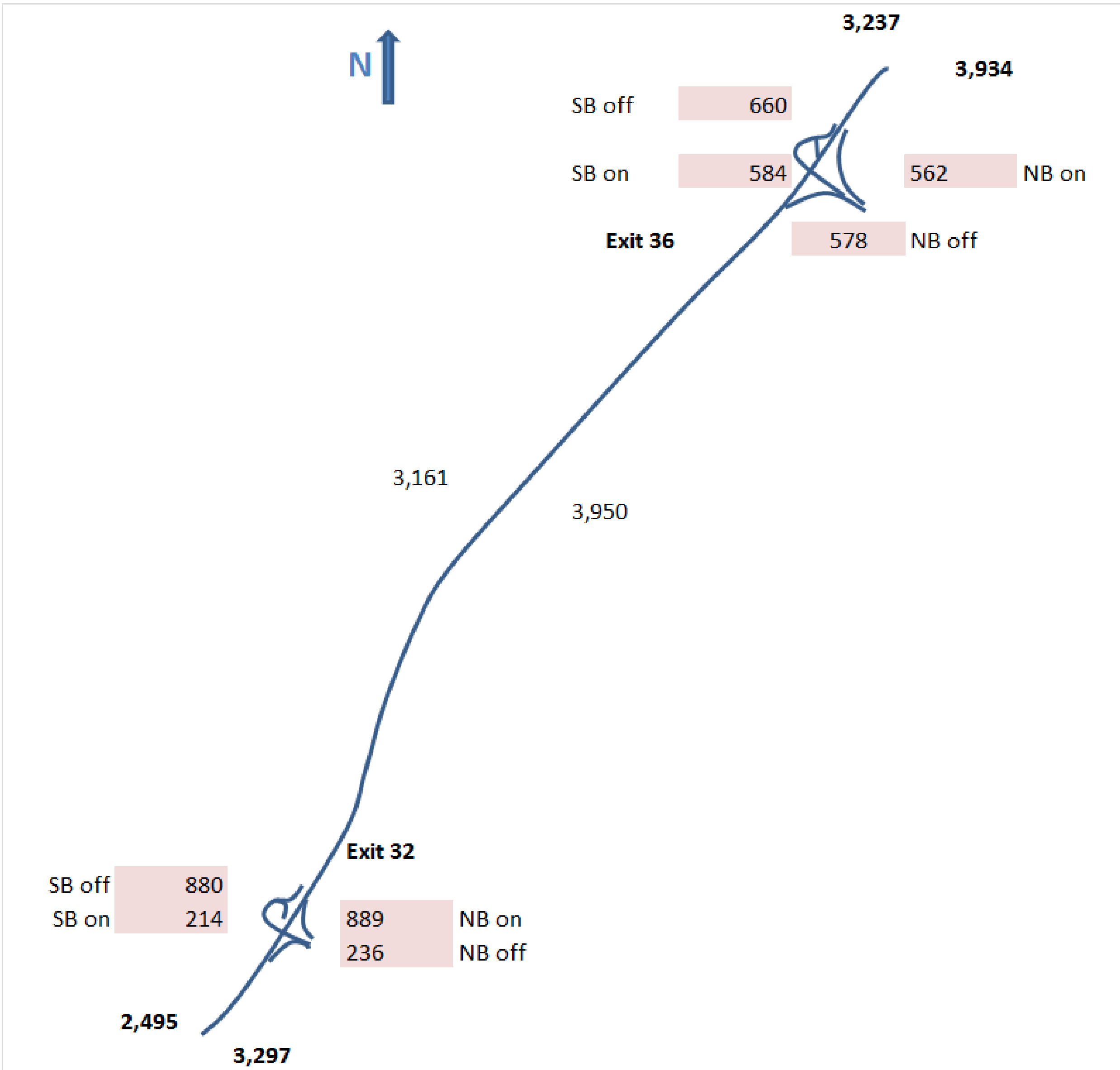


Figure 6-3 – Friday Afternoon Peak Hour Volumes in the Biddeford/Saco Area Balanced to Critical Link



6.2 2014 Traffic Analysis

The baseline traffic analysis for the Biddeford/Saco area provides insight into current traffic conditions and can be used to compare with future traffic conditions in the study area. The balanced critical peak hour traffic volumes were developed from the hourly traffic count data that is continuously collected by the Authority.

The baseline AM, PM and Friday peak hour traffic volumes were input into the VISSIM model and analyzed. The LOS and 95th percentile queues for each of the Biddeford/Saco area interchanges and mainline segments are illustrated in Table 5-1.

Table 6-1 – 2014 LOS & Queue Summary for the Biddeford/Saco Area

	AM		**PM**		**Friday**	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
32 NB off	A	--	A	--	B	--
32 NB on	B	NO	B	NO	B	NO
32 SB off	B	--	C	--	B	--
32 SB on	A	NO	A	NO	B	NO
36 NB off	B	--	A	--	B	--
36 NB on	C	NO	B	NO	C	NO
36 SB off	B	--	C	--	B	--
36 SB on	A	NO	B	NO	B	NO
32-36 NB	B	--	B	--	C	--
32-36 SB	B	--	B	--	B	--

As can be seen from Table 5-1, all mainline sections, merge and diverge areas are shown to operate at an acceptable LOS during 2014. However, it should be noted that the model includes only the Turnpike mainline and ramps. Local intersections and toll plazas (and their influence on traffic operations) are not included in the VISSIM model results shown above. However, an additional analysis was performed for the Exit 36 off-ramp which included I-195 EB to the off-ramp to Industrial Park Road and the intersection of Industrial Park Road at the I-195 off-ramp (see Appendix F).

It has been observed that queues from the Exit 36 and Exit 32 southbound off ramps contribute to significant traffic congestion during the afternoon peak hours. The VISSIM analysis shows that the congestion that is currently experienced at the Exit 36 and 32 southbound off-ramps is not due to any capacity restraints on the Turnpike mainline or the ramps, but rather the influence of adjacent local intersections.

6.3 2024 Traffic Analysis

The 2014 balanced peak hour traffic volumes were increased at a rate of 1.6% per year to the design year of 2024. The estimated 2024 peak hour traffic volumes were input into the traffic capacity model and analyzed. The LOS and 95th percentile queues for the Biddeford and Saco interchanges and mainline sections are illustrated in Table 5-2.

Table 6-2 – 2024 LOS and Queue Summary for the Biddeford/Saco Area

	AM		**PM**		**Friday**	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
32 NB off	A	--	B	--	C	--
32 NB on	B	NO	B	NO	C	NO
32 SB off	B	--	E	--	C	--
32 SB on	A	NO	A	NO	B	NO
36 NB off	B	--	B	--	B	--
36 NB on	D	NO	B	NO	D	NO
36 SB off	B	--	D	--	C	--
36 SB on	B	NO	B	NO	B	NO
32-36 NB	B	--	B	--	C	--
32-36 SB	B	--	B	--	C	--

As can be seen from Table 5-2, the Exit 32 SB off ramp can be expected to operate at a LOS E and the Exit 36 SB off ramps can be expected to operate at a LOS D. However, the LOS shown for these ramps is misleading as the LOS measurements in VISSIM depend on how well traffic moves through the system. And it is already observed that traffic queues from the adjacent signal already cause delays for these ramps. What this does show is that by 2024, the Turnpike mainline and diverge area at Exit 32 will not have sufficient capacity to handle the expected traffic.

6.4 2034 Traffic Analysis

The 2014 balanced peak hour traffic volumes were increased at a rate of 1.6% per year to the design year of 2034. The estimated 2034 peak hour traffic volumes were input into the traffic capacity model and analyzed. The LOS and 95th percentile queues for each of the Biddeford/Saco area interchanges and mainline sections are illustrated in Table 5-3.

Table 6-3 – 2024 LOS and Queue Summary for the Biddeford/Saco Area

	AM		PM		Friday	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
32 NB off	B	--	B	--	C	--
32 NB on	B	NO	B	NO	F	YES – 873 ft.
32 SB off	B	--	F	--	C	--
32 SB on	A	NO	A	NO	B	NO
36 NB off	B	--	B	--	C	--
36 NB on	E	YES – 728 ft.	B	NO	F	YES – 842 ft.
36 SB off	B	--	F	--	C	--
36 SB on	B	NO	B	NO	C	NO
32-36 NB	C	--	B	--	D	--
32-36 SB	B	--	C	--	C	--

As can be seen from Table 5-3, the following on-ramps and off-ramps are expected to function at a LOS F by 2034:

- Exit 32 SB off
- Exit 36 SB off
- Exit 32 NB on
- Exit 36 NB on

The following ramps are expected to have long queues (more than 200 feet) indicating that ramp traffic has difficulty finding gaps in the mainline traffic stream and is operating over-capacity. And as a consequence the traffic density, and subsequently the LOS may be under-represented at the adjacent mainline link:

- Exit 36 NB on-ramp
- Exit 32 NB on-ramp

Even though not all links are mentioned on the above list, certain links may have traffic densities that are under-represented due to traffic congestion on an upstream link. Accordingly, some mainline links were grouped into projects so that increased traffic flow from one area to the next would not result in traffic congestion on an unimproved link. Table 5-4 shows when projects should be completed in the Saco/Biddeford area and how the results compare with those obtained from the HCM analysis of the previous sections.

Table 6-4 – Timeline for Biddeford/Saco Area Improvement Projects

Exit #/ Segment Mileage	Year from VISSIM Analysis	Year from HCM Analysis	Improvement Project
32 SB off-ramp	2026	2021	Ramp Widening
32 NB on-ramp	2031	2026	Ramp Widening
36 NB on-ramp	2025	2022	Ramp Widening
36 SB off-ramp	2034	2032	Ramp Widening
36 NB off-ramp	beyond 2034	2023	Ramp Widening

As can be seen from Table 5-4, the VISSIM results are slightly different from the HCM results. The major reason for the differences is the nature of the analyses. HCM analyzes isolated roadway sections while VISSIM analyzes an entire area, and considers how traffic congestion impacts other areas. Another big difference from an HCM analysis and a VISSIM analysis is year at which a roadway segment becomes a LOS E. By definition, a LOS E condition reflects a traffic condition that is unstable. Since HCM is a macro-analysis tool, the traffic numbers input into the analysis will consistently result in a certain LOS. But, VISSIM is a micro-simulation analysis whose results are more varied. With unstable traffic flow, if a few vehicles stall in the traffic stream, then queues can develop and traffic density will increase even in adjacent roadway links. As a result, VISSIM does not necessarily show LOS E for a several year span as an HCS analysis would.

It should be noted that congestion on the Exits 32 and 36 southbound off-ramps is currently a problem. However, this limited VISSIM analysis, which evaluated the Turnpike mainline and the ramps only, did not show a LOS of F until 2026. This indicates that there are traffic issues downstream of the ramps, most likely the adjacent signalized intersections. If the off-ramps were widened without addressing the current bottlenecks at the intersections, the traffic operations would not improve. Further analysis of the Exit 36 southbound off-ramp is included in Appendix F.

7 SAFETY CONDITIONS

The safety analysis for this study determined if there are locations with a high crash history, determined if there are measures that can be taken to alleviate the number of crashes, and examined the current safety practices of the Authority and the efficacy of those practices. In addition, HNTB re-examined the safety issues and recommendations identified in the last systemwide traffic operation and safety study and determined the status of those previously identified safety concerns.

All mainline miles, interchanges, ramps and toll plazas on the Maine Turnpike as well as adjacent intersections to the Turnpike were analyzed for this safety analysis. The data used was obtained from MaineDOT: Traffic Engineering, Crash Records Section. The crash study period analyzed is the most recent three year period for which data is available – January 2012 to December 2014.

7.1 Crash Rate Comparison

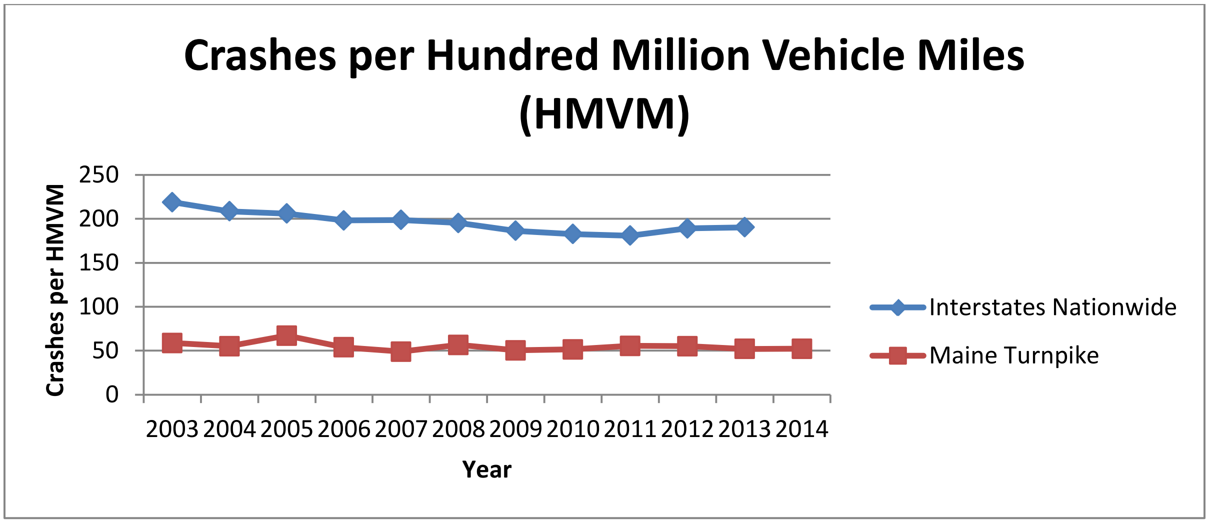
During the 36 month period (2012-2014), a total of 2,005 crashes were recorded on the Turnpike mainline. Of the 2,005 crashes, 943 occurred in the southbound direction of travel while 1,062 occurred in the northbound direction of travel.

The number of crashes that occur on a roadway is correlated with the amount of traffic on a roadway. In other words, more traffic would generally tend to increase the occurrence of crashes. Similarly, a decline in traffic would generally cause a decrease in the number of crashes. In order to draw comparisons of occurrence of crashes, crash rates are developed, which are the number of crashes divided by the vehicle miles traveled. During the three year period of 2012-2014, there were approximately 55.5 crashes per hundred million vehicle miles traveled on the Turnpike.

For comparison purposes, the same statistics were reviewed from the 2012 Systemwide Traffic Operations and Safety Study, which analyzed crash data from January 2009 to December 2011. During that time period the crash rate was approximately 52.3 crashes per hundred million vehicle miles traveled. The data shows that the crash rate for the 2012-2014 study period is higher than the crash rate for the 2009-2011 study period. It should be noted that the speed limit on the Turnpike increased in August 2014. The speed limit change happened late in the three-year study period and, therefore, its impact on crash rates cannot be determined at this time.

Data were also gathered on crash rates for the national interstate highways. Figure 6-1 compares the crash rates on the Maine Turnpike with those on the national Interstate System from 2003 through 2010. As can be seen from Figure 6-1, the Turnpike crash rate is lower than the national average crash.

Figure 7-1 – Crash Rate Comparison 2003-2010



Note: 2014 crash data was not available for interstates nationwide.

7.2 Current Safety Practices

The Authority has implemented many safety practices to promote safe travel along the highway. Those practices include roadside improvement programs, ITS (Intelligent Transportation Systems) upgrades, emergency vehicle access ramps, and maintenance practices.

<u>ROADSIDE IMPROVEMENT PROGRAMS</u>

The roadside improvement programs that the Authority is currently undertaking are the following:

- Assessing all median openings for required criteria of sight distance. All openings that do not meet standards are either improved to meet criteria or closed.
- Upgrading all out-of-date guard rail end treatments and adjusting guard rail height where necessary
- Checking all clear zones and increasing distance where practicable. These measures consist mainly of modifying ditching, flattening slopes, clearing vegetation in close proximity to the, and removing ledge.

<u>ITS UPGRADES</u>

The Authority has made the following ITS upgrades since 2012 to promote safe and efficient travel:

- Installation of a fiber optic line between Exit 46 and the Maine Turnpike Headquarters.
- The addition of eight new flashing 45 MPH Reduced Speed Limit signs that are controlled remotely from the Turnpike communication center.
- Placement of additional VMS (portable and semi-permanent) along the highway at strategic locations to provide motorists with pertinent travel information.
- Installation of additional over height vehicle detection systems.

EMERGENCY VEHICLE ACCESS RAMPS (EVRs)

Emergency vehicle access ramps are gated ramps between the mainline and a local road that allows authorized vehicles such as MTA vehicles, fire trucks, police, and ambulance vehicles to access the Turnpike mainline. EVRs enhance safety by minimizing the need for median openings and allow authorized vehicles to reverse direction without having to cross mainline traffic. EVRs have recently been installed at Academy Road in Litchfield (MM 92.7) and Route 122 in Auburn (MM 74.0). EVRs are planned at Hackett Road (MM 76.9) in Auburn and at Two Rod Rd in Scarborough (MM 42.0). The Authority is currently evaluating additional locations to install EVRs. Evaluation criteria include interchange spacing, plowing routes, and access for emergency vehicles.

MAINTENANCE PRACTICES

In addition to these programs, standard maintenance measures are constantly undertaken to improve traveling conditions and, in turn, safety conditions along the length of the Turnpike. Examples of these regular maintenance practices are:

- Re-striping all lines annually
- Increasing use of retroreflective tape and lane markings
- Repairing pot-holes
- Filling cracks as part of resurfacing projects
- Regularly cleaning/maintaining storm drainage systems
- Pre-treating the roadway before major winter storms
- Sweeping excess sand from the roadway
- Selectively choosing when to allow lane closures for both construction and maintenance activities so that the impact on traffic flow is minimal
- Keeping shoulder areas cleared of trash and debris
- Maintaining vegetation growth on side slopes to increase visibility and promote melting of winter snow and ice
- Repairing guardrail as soon as possible following crash damage
- Maintaining 60 inch Yield signs at every entry ramp
- Adding Stop and One-Way signs at maintenance and emergency access points
- Adding or Repositioning Wrong Way signs and employing other countermeasures as appropriate

INCIDENT MANAGEMENT

The Authority has a program to manage and prevent incidents, which includes the following:

- Providing a night patrol to monitor the highway and notify crews of dangerous driving conditions
- Participating as an active charter member of two Traffic Management Committees in order to improve safety for responders and motorists while minimizing the impact incidents have on the normal flow of traffic
- Removal of disabled vehicles in a timely manner
- Coordinating quick clearance practices with emergency responders
- Directly communicating with first responder vehicles for immediate information relay

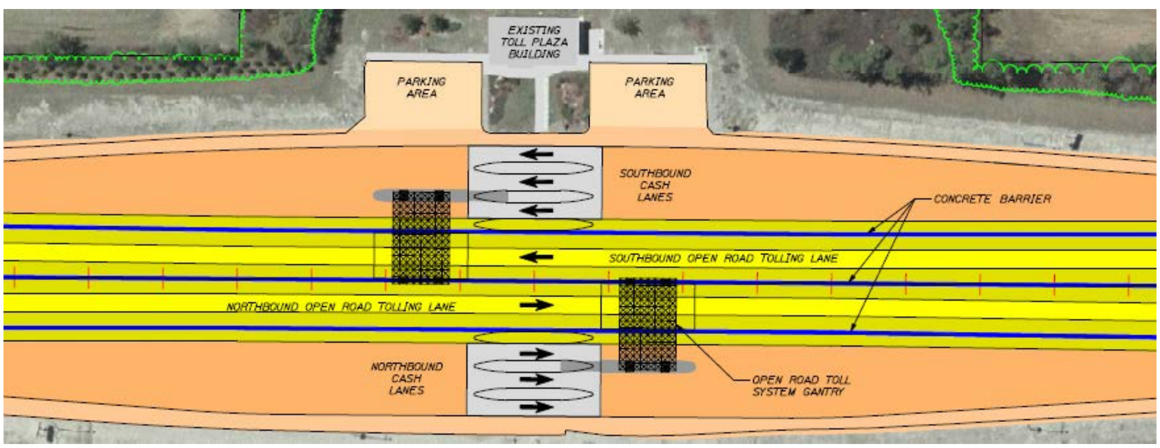
7.3 Safety Improvement Projects

The Authority has recently awarded several construction contracts that will enhance safety at the toll plazas (which historically have high crash rates) through improved operation, capacity, and geometry at these locations. A summary of these construction projects is provided in the following sections.

OPEN ROAD TOLLING CONVERSION PROJECTS

The Authority is currently in the process of converting both the West Gardiner and Falmouth Spur toll plazas to allow for open road tolling (ORT). These projects involve the removal of the four middle toll lanes at the plaza and replacing them with one highway speed ORT E-ZPass Only lane in each direction. These ORT lanes will include concrete barrier walls separating each direction as well as separation from the remaining cash toll lanes. Customers with E-ZPass will no longer be required to slow down or stop at the toll plaza. These customers will be able to use specially designed barrier separated toll lanes for non-stop tolling as shown in Figure 6-2.

Figure 7-2 – ORT Tolling Layout



Once completed, the West Gardiner and Falmouth Spur toll plaza ORT conversions will provide multiple safety improvements. With approximately 60% of the transactions at West Gardiner and 70% of the transactions at the Falmouth Spur paid via E-ZPass, the potential for reducing traffic crashes at both plazas is significant. On approach to either of the toll plazas, the driver is directed to select either the ORT or cash side of the plaza well in advance of the plaza itself. From a traffic operations and crash potential perspective, these plazas are more akin to a highway split or interchange ramp than a traditional toll plaza. The result is a reduction in conflicts between vehicles of differing speeds and reduced weaving in the cash lanes related to lane changing. Based on historical data reported by major facility conversions to ORT in states such as Florida, New Jersey, Texas and Illinois, crashes have been reduced by as much as 50-60%. Therefore ORT has significant opportunity to improve the safety of the traveling public.

In addition to reducing vehicle crashes at the toll plaza, ORT will also reduce the exposure of toll collectors to non-stop traffic and total traffic in general. Toll collectors will continue to have the benefit of the tunnel to access the plaza. In some cases, the safety of the tunnel will be the only means of access since the ORT lanes will eliminate the option for collectors to cross the entire plaza at the roadway level to access toll lanes. A reduction in exposure to cash traffic coupled with virtual elimination of exposure to E-ZPass traffic will improve the safety of toll collectors.

EXIT 32 TOLL UPGRADES

Construction on a project to upgrade the Exit 32 toll plaza is scheduled to begin in late 2015 or early 2106. This project will move the gore between the southbound and northbound on ramps approximately 85' further way from the toll plaza. This gore shift will increase the weave distance patrons have upon leaving the toll plaza and jockeying position to select the proper entrance ramp. This increased length should improve operations and reduce sideswipe collisions.

This project at Exit 32 will also add an additional toll lane which will reduce the length of queues at the toll booths. Shorter queues may reduce the frequency of rear end collisions occurring at the toll plaza associated with stopped vehicles waiting to pay a toll.

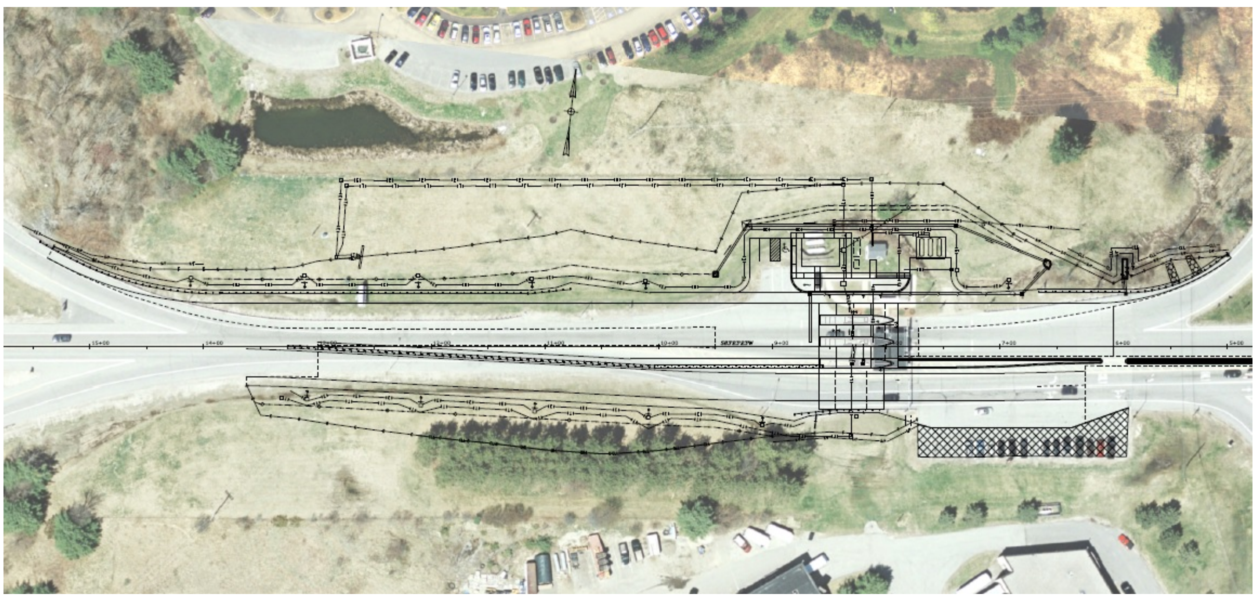
Figure 7-3 – Exit 32 Proposed Highway Layout

EXIT 53 TOLL UPGRADES

Construction on a project to upgrade the Exit 53 toll plaza is scheduled to begin in late 2015 or early 2106. This project will remove and reset the median guardrail to improve the lengths of the toll plaza departure recovery zone and transition zone. The proposed departure recovery zone and departure transition zone will now meet current design standards for length thus giving patrons adequate time for re-orientation, acceleration, and merging after exiting the plaza. This will likely reduce the frequency of sideswipe collisions.

This project at Exit 53 will also add an additional toll lane which will reduce the length of queues at the toll booths. Shorter queues may reduce the frequency of rear end collisions occurring at the toll plaza associated with stopped vehicles waiting to pay a toll.

Figure 7-4 – Exit 53 Proposed Highway Layout



7.4 Other Studies

The Authority has also recently conducted several studies regarding mobility and safety issues. Those studies deal with improvements to some of the intersections adjacent to the Turnpike as well as future transportation needs in identified corridors.

GORHAM EAST-WEST CORRIDOR FEASIBILITY STUDY

The purpose of this study was to develop a series of recommendations to enhance, expand, and preserve highway connections between Route 1 and the Maine Turnpike and communities in western Cumberland County. This study focused on the effects that land use has on transportation and developed a coordinated land use, transit, and highway improvement strategy to reduce future demand on the regional transportation network.

The Phase I Study and Report was completed in October 2012. The Authority is working with the Army Core of Engineers (ACOE) to identify alternatives for further evaluation. Results of an ACOE evaluation could result in a new connection to the Turnpike, which will have an impact on future traffic estimates in the Portland area.

7.5 High Crash Locations

MaineDOT has a system of classifying whether or not a particular roadway location is considered a high-crash location (HCL). MaineDOT's Crash Records Section summarizes all reported crashes in which there is property damage in excess of $1000, or in which there has been personal injury. In order to summarize this information, the MaineDOT has established a Node and Element System. This system assigns a four or five-digit node number to each intersection, major bridge, railroad crossing, and crossing of town, county, or urban compact lines as a node. The segments of road that connect the nodes are referred to as elements. As crash reports are received by MaineDOT, the information is assigned to the corresponding element or node at which they occurred.

A designation of HCL warrants an analysis for patterns of crashes associated with possible geometric issues. If crash history of a particular element or node meets two criteria, then MaineDOT would classify it as a high-crash location (HCL). The criteria are:

- The element or node must have eight or more reported crashes over the past three years
- The element or node must have a "critical rate factor" (CRF) greater than 1.00. (The critical rate factor relates the crash rate at a particular element or node to the statewide crash rate average for a similar type of facility)[3].

This study identifies the mainline segments, ramps, and intersections adjacent to the Turnpike which are HCLs. The following sections show how the HCLs have changed in the past 4 years and provides an analysis for the current HCLs.

7.5.1 High Crash Locations 2009-2011 Update

Table 6-1 lists the high crash locations on the Turnpike mainline for the period 2009-2011. This was the period studied in the previous systemwide traffic operations and safety study published in 2012.

[3] Critical rate factors are computed differently for nodes and elements. The calculation for a critical rate factor for an element includes the length of the element. Nodes essentially have no length. Therefore, the critical rate factors for nodes are not necessarily comparable to the critical rate factors for elements.

Table 7-1 – 2009-2011 HCLs on the Maine Turnpike

	Town	*Node/Element*	*Description*	*Crashes*	*CRF*
Toll Plaza Nodes	York	57692	Mile post 7.13 - NB approach to York Barrier Toll plaza	11	3.73
	York	57693	Mile post 7.13 - SB approach to York Barrier Toll plaza	10	3.36
NB Segments	Wells	239695	Exit 19 NB merge area to Burnt Mill Rd	10	1.04
	New Gloucester	195030	0.48 miles from New Gloucester Barrier Toll plaza to Mayall Rd.	9	1.29
SB Segments	West Gardiner	2524169	0.78 miles from High Street to West Gardiner/Farmingdale TL	17	1.24
	New Gloucester	2523347	0.84 miles from Shaker Road to Bald Hill Road	11	1.03
	New Gloucester	2523359	1.14 miles from Mayall Road to Bennett Road	17	1.25
	New Gloucester	2523361	0.48 miles from New Gloucester Barrier Toll plaza to Mayall Rd.	13	1.86
	York	2522897	York Barrier Toll Plaza to York Interchange	10	2.38
Turnpike Ramps	Wells	239745	0.27 miles, Exit 19 SB Off Ramp	8	3.71
	Kennebunk	239756	0.51 miles, Exit 25 SB Off Ramp	9	2.57
	Biddeford	239715	0.13 miles from local street (toll plaza), Exit 32 On Ramp	8	1.62
	Falmouth	2036928	0.17 miles from local street (toll plaza), Exit 53 On Ramp	8	2.00
	Portland	2836952	0.07 miles from local street (toll plaza), Exit 48 Off Ramp	8	2.92
Ramp Intersections With Local Roads	Kittery	58964	Exit 2 Off Ramp & Rodgers Road	11	2.42
	Wells	58365	Exit 19 Off Ramp & Sanford Road	19	1.09
	Portland	18670	Exit 48 Off Ramp & Riverside Street & Larrabee Road	52	1.91
	W. Gardiner	28516	Exit 102 Ramps & Routes 9/126	25	19.91

Each of the 2009-2011 HCLs will be discussed briefly to review the recommendations that were made previously and the current status of those locations.

1. Mile post 7.13 - NB approach to York Barrier Toll plaza

Original Recommendation: This has been a high crash location for a number of years and is largely due to poor geometrics. Many improvements have been considered including rebuilding the York toll plaza as an ORT facility.

Status: This location is still an HCL. The York toll plaza is planned to be rebuilt as an ORT .

2. Mile post 7.13 - SB approach to York Barrier Toll plaza

Original Recommendation: This has been a high crash location for a number of years and is largely due to poor geometrics. Many improvements have been considered including rebuilding the York toll plaza as an ORT facility.

Status: This location is no longer an HCL.

3. Exit 19 NB merge area to Burnt Mill Rd

Original Recommendation: Half of all reported accidents at this location occurred during inclement weather for the 3 year span between 2009 and 2011; therefore, in consultation with Authority staff, HNTB Corporation recommended the installation of pavement sensors. It was also recommended that on ramp at this location be converted from a taper ramp to a parallel ramp to provide a longer merge area for entering traffic

Status: The on ramp at this location was converted from a taper on-ramp to a parallel on-ramp. This location is no longer an HCL.

4. New Gloucester Barrier Toll plaza to Mayall Rd. NB lanes

Original Recommendation: Toll plazas commonly experience high crash rates due to the disruption of mainline traffic flow. No recommendations were provided in the 2012 Systemwide Traffic Operation and Safety Study as this plaza was in the process of being converted from a conventional toll plaza to an ORT style plaza at that time.

Status: Conversion of this toll plaza to an ORT style plaza is complete. This location is no longer an HCL.

5. High Street to West Gardiner/Farmingdale TL

Original Recommendation: Over 82% of all crashes between 2009 and 2011 at this location reportedly occurred when the roadway was classified as "wet" during a rain event. In consultation with Authority staff, HNTB Corporation recommended resurfacing this section of highway to eliminate rutting in the wheel paths.

Status: This section of highway was resurfaced in 2014. This location is no longer an HCL.

6. Shaker Road to Bald Hill Road

Original Recommendation: HNTB Corporation recommended that maintenance pay particular attention to this area during inclement weather conditions as over 36% of all crashes that occurred at this location between 2009 and 2011 were reported to have occurred during snow or ice conditions.

Status: This location is no longer an HCL.

7. Mayall Road to Bennett Road

Original Recommendation: Many crashes at this location were either a result of driver behavior (i.e. distracted driver, speeding, or driving too fast in inclement conditions) or a disruption of mainline traffic flow due to its close proximity to the New Gloucester toll plaza. HNTB Corporation expected that converting the New Gloucester toll plaza from a conventional toll plaza to an ORT style toll plaza would result in a reduction in the number of crashes at this location.

Status: The New Gloucester toll plaza has been converted from a conventional toll plaza to an ORT style toll plaza. This location is no longer an HCL.

8. New Gloucester Barrier Toll plaza to Mayall Rd. SB lanes

Original Recommendation: Toll plazas commonly experience high crash rates due to the disruption of mainline traffic flow. No recommendations were provided in the 2012 Systemwide Traffic Operation and Safety Study as this plaza was in the process of being converted from a conventional toll plaza to an ORT style plaza at that time.

Status: Conversion of this toll plaza to an ORT style plaza is complete. This location is still an HCL and will be discussed further in this study.

9. York Barrier Toll Plaza to York Interchange

Original Recommendation: The close proximity of the York Toll Plaza to the York interchange results in a turbulent weave on the departure side of the toll plaza resulting in a large number of sideswipe crashes. In consultation with Authority staff, HNTB Corporation recommended that advance overhead signing with a clear message about which toll lanes are best to use at the York plaza for accessing the York interchange be installed in advance of the plaza.

Status: Overhead signing modifications have been implemented. This location is no longer an HCL.

10. Exit 19 SB Off Ramp

Original Recommendation: Half of all crashes at this location between 2009 and 2011 were caused by fatigued drivers. In consultation with Authority staff, HNTB Corporation recommended the installation of Sonic Nap Alert Patterns (SNAPs) be installed at this location.

Status: In addition to SNAPS, the Authority also added chevrons to the ramp. This location is no longer an HCL.

11. Exit 25 SB Off Ramp

Original Recommendation: Eight out of nine crashes at this location were caused by drivers backing up on the ramp. The exit ramp splits a second time shortly after the ramp diverges from the Turnpike mainline. In consultation with Authority staff, HNTB Corporation recommended that the guide signs at this interchange be reviewed for effectiveness and clarity.

Status: The Authority has revised the guide signs at this location. This location is no longer an HCL.

12. Exit 32 Ramp

Original Recommendation: While no obvious geometric flaw or other cause (i.e. weather) could be identified at this location, HNTB Corporation recommended watching this site in future years to see if it continued to be classified as an HCL and if a pattern developed.

Status: This location is still an HCL and will be discussed further in this study.

13. Exit 53 Ramp

Original Recommendation: While no obvious geometric flaw or other cause (i.e. weather) could be identified at this location, HNTB Corporation recommended watching this site in future years to see if it continued to be classified as an HCL and if a pattern developed.

Status: The Authority installed a guardrail separating northbound and southbound ramp traffic west of the toll plaza. This location is no longer an HCL.

14. Exit 48 Ramp

Original Recommendation: In consultation with Authority staff, HNTB Corporation recommended that improved advanced signing be installed on all legs of the intersection with the local road to encourage unfamiliar drivers to choose the correct lane well in advance of the toll plaza as the decision making distance between the intersection with the local road and the toll plaza is less than 0.10 miles.

Status: The Authority added overhead lanes use signage on the off ramp prior to the intersection and also revised the pavement markings approaching the intersection. This location is no longer an HCL.

15. Exit 2 Off Ramp & Rodgers Road

Original Recommendation: Ten out of eleven crashes at this location between 2009 and 2011 were rear-end type crashes occurring at the end of the off ramp as traffic yields to the two lanes of through traffic on Route 236. HNTB Corporation made the following recommendations:

1. Curve arrow signs on the ramp are covered by grass, the grass should be cut so that the signs are visible.
2. Trees and shrubs in the gore of the intersection should be trimmed and maintained to improve sight distance for merging traffic.
3. Install advanced signs on the ramp warning of the yield ahead.
4. Reconfigure the ramp to approach Route 236 at a sharper angle to increase vehicle visibility for approaching Route 236 traffic.

Status: This location was not part of the Maine Turnpike until early 2015, when the Authority purchased it. This location is still an HCL.

16. Exit 19 Off Ramp & Sanford Road

Original Recommendation: This location has been observed to have lengthy queues particularly on the off ramps leading to a number of rear-end crashes. HNTB Corporation recommended retiming of the traffic signal and restriping of the intersection to reduce queues on all approaches to the intersection. Additional improvements were also noted in the Central York County Connections Study including the installation of double left-turn lanes off from the interchange ramps and onto Route 109.

Status: The Authority completed capacity and signal improvements at the intersection in 2015. This location is no longer an HCL.

17. Exit 48 Off Ramp & Riverside Street & Larrabee Road

Original Recommendation: Between 2009 and 2011 a total of 52 crashes occurred at this signalized intersection. Of those, 43 crashes were classified as rear-end/sideswipe. HNTB Corporation recommended that the signs and pavement markings of the westbound approach be studied further for possible modifications, and that the Authority coordinate with the local municipalities and the MaineDOT regarding improvements for the other legs of the intersection.

Status: This location is still an HCL.

18. Exit 102 Ramps & Routes 9/126

Original Recommendation: HNTB Corporation recommended the installation of a traffic signal at this location to reduce the number of crashes that may have been the result of limited sight distance.

Status: This location is still an HCL; however, a roundabout is currently being installed at this location.

7.5.2 Current High Crash Locations of the Maine Turnpike

This safety analysis examined the crash data of designated high crash locations to determine patterns and potential remedies. According to the most recent MaineDOT data available which dates from January 2012 through December 2014 there are seven areas classified as HCLs on the Turnpike mainline. The northbound travel lane has four HCLs while the southbound travel lane has three. An additional three entry and exit ramp locations and five intersections with local roads were identified as HCLs.

Table 6-2 below shows a summary of the high-crash locations located on the Turnpike mainline and interchange ramps as well as those located at the intersections of the interchange ramps with the local roads. Each HCL that is located on either the Turnpike mainline or an interchange ramp is discussed in the following paragraphs. HCLs that are located at intersections with local roads are identified but not analyzed. These locations are not entirely within the jurisdiction of the Authority. Improvements to these locations would need to be coordinated with local agencies and MaineDOT.

Table 7-2 – 2012-2014 HCLs on the Maine Turnpike

	Town	Node/Element	Description	Crashes	CRF
Toll Plaza Nodes	York	57692	Mile post 7.13 - NB approach to York Barrier Toll plaza	8	3.27
NB Segments	Saco	3114584	0.38 miles from Biddeford-Saco Town Line to Boom Rd.	16	1.05
	Falmouth	3120767	0.43 miles from Falmouth-Cumberland Town Line to Hurricane Rd.	13	1.58
	West Gardiner	3123465	1.0 miles from Litchfield-West Gardiner Town Line to West Gardiner Barrier Toll Plaza	8	1.11
SB Segments	Augusta	3119831	0.41 miles from Northern End Maine Turnpike to Augusta-Hallowell Town Line	12	1.20
	New Gloucester	3115776	0.49 miles from New Gloucester Barrier Toll plaza to Mayall Rd.	8	1.15
	Kittery	3121414	0.55 miles from New Hampshire-Maine State Line to Exit 1	26	1.10
Turnpike Ramps	Biddeford	239715	0.13 miles from local street (toll plaza), Exit 32 On Ramp	8	1.43
	Saco	3114457	0.18 miles from Exit 36 Toll Plaza to I-195 Exit 1	9	1.57
	South Portland	14585	Intersection of Turnpike Approach & Maine Mall Rd. On Ramp	12	3.29
Ramp Intersections With Local Roads	Kittery	58964	Exit 2 Off Ramp & Rodgers Road	9	2.14
	South Portland	15531	Exit 45 On Ramp & Maine Mall Rd.	37	1.35
	Portland	18670	Exit 48 Off Ramp & Riverside Street & Larrabee Road	68	1.88
	Biddeford	58334	Exit 32 Ramps & Alfred St & Biddeford Spur	56	1.14
	West Gardiner	28516	Exit 102 Ramps & Route 9/126	13	13.68

1. York Interchange to York Barrier Toll Plaza NB Lanes – Mile 7.13

This brief section of highway encompasses the area from the York interchange to the York Barrier Toll Plaza. The types of crashes recorded are similar to most toll plazas where mainline traffic flow is interrupted: All eight crashes are either rear end or sideswipe crashes. The close proximity of the barrier toll plaza to the York interchange contributes to lane change issues by adding another stream of traffic flow accessing lanes to the plaza over a short distance.

The area between the York Barrier Toll Plaza and the York interchange has been a high crash location for a number of years. Improvements to the York Toll Plaza are currently being considered, including the possibility of rebuilding the York Toll Plaza as an ORT facility.
Total number of crashes: 8, CRF: 3.27

2. Biddeford-Saco Town Line to Boom Road Bridge – NB Lanes

This section is described as the mainline bridge over the Saco River to the Boom Road Bridge for a distance of 0.38 miles. This section of road is on a curve. This covers northbound traffic. Six of the sixteen crashes in this section occurred when the roadway surface was classified as snow or ice/frost covered. Two of the crashes were deer collisions. Nine of the crashes occurred when it was dark. Seven of the sixteen crashes involved drivers that were driving too fast for conditions.

A flashing advisory speed limit sign could be installed in advance of this section to alert drivers of roadway conditions. This area should be considered by the Authority in its review of large animal collisions on the Turnpike.
Total number of crashes: 16, CRF: 1.05

3. Cumberland-Falmouth Town Line to Hurricane Road Bridge – NB Lanes

This section is a 0.43 mile area from the Cumberland-Falmouth town line to the Hurricane Road Bridge. This section covers northbound traffic only. Five of the thirteen crashes are animal collisions at night. Five of the thirteen crashes are when the roadway surface is wet or snow/slush covered. Nine of the thirteen crashes happened when it was dark.

This section has poor pavement conditions and is planned for rehabilitation in 2016. Clearing occurred here in early 2014 which should help improve visibility. Also, an acceleration lane has been added and the nearby bridges have been raised which will also improve visibility. These recent improvements may help to reduce the crash rate. This area should be considered by the Authority in its review of large animal collisions on the Turnpike.
Total number of crashes 13 CRF: 1.58

4. Litchfield-West Gardiner Town Line to West Gardiner Barrier Toll Plaza – NB Lanes

This section is a 1.0 mile area north of the Litchfield-West Gardiner town line to the West Gardiner Barrier Toll Plaza. This section covers northbound traffic only. This location has three rear end/sideswipe crashes and one vehicle hit a toll booth. These crashes are similar to other toll plazas where mainline traffic flow is disrupted. The West Gardiner toll plaza is currently being modified to an Open Road Tolling facility.

HNTB Corporation recommends that this location be monitored in the future to determine safety impacts the conversion to Open Road Tolling has had at this location. It is expected that this facility change will reduce the crashes occurring at this location.
Total number of crashes 8 CRF: 1.11

5. Augusta-Hallowell Town Line to Northern End of Maine Turnpike – SB Lanes

This section is a 0.41 mile area from the Augusta-Hallowell town line to the northern end of the Maine Turnpike. This section covers southbound traffic only. Eight of the twelve crashes are off road type crashes. Six of the twelve crashes occurred on a wet roadway surface. Hydroplaning is mentioned in some of the crash descriptions. This hydroplaning may be due to water pooling in wheel ruts in this section. This section of roadway was repaved in 2014 at the end of the crash report study period.

HNTB Corporation recommends that this location be monitored in the future to determine if the repaving will reduce the frequency of hydroplaning crashes.
Total number of crashes 12 CRF: 1.20

6. Gray-New Gloucester Town Line to Mayall Road Bridge – SB Lanes

This section is a 0.49 mile area just north of the New Gloucester Barrier Toll Plaza to the Mayall Road Bridge. This section covers southbound traffic only. This toll plaza was modified to an Open Road Tolling facility during the crash analysis period; 9/2013. Three of the eight crashes occurred after this conversion.

HNTB Corporation recommends that this location be monitored in the future to determine safety impacts the conversion to Open Road Tolling has had at this location.
Total number of crashes 8 CRF: 1.15

7. Maine-New Hampshire State Line to Exit 1 – SB Lanes

This section is a 0.55 mile area north of the Maine-New Hampshire state line to Exit 1. This section covers southbound traffic only. This location has fifteen rear end/sideswipe crashes. Twelve of the twenty six crashes at this location occur on Sundays and Mondays between 11:30 a.m. to 8:00 p.m. Many of the crash descriptions report a vehicle rear ending another vehicle while the first vehicle is slowing or stopping in traffic. This area has traffic delays and queues on Sundays and Mondays for a portion of the year. Nine of these Sunday and Monday crashes occur when heavy traffic is likely. Also eight of the twenty six crashes occurred on wet or snowy road surfaces.

The Authority is considering adding a Roadway Weather Information Station in this area to provide advance warning and roadway condition monitoring during storms (near Piscataqua River Bridge and on York River Bridge). Also, the Authority is considering additional cameras in this area.
Total number of crashes 26 CRF: 1.10

8. Exit 32 Ramps, Biddeford

This section is described as the Exit 32 ramps from the intersection with the local road for a distance of 0.13 miles. This covers both entering and exiting traffic. Crashes in this location include eight rear end and sideswipes. Seven of the eight crashes occurred during clear weather with a dry roadway surface. Four of the eight crashes are rear end crashes of cars stopped at the toll plaza.

A toll plaza project will be constructed at this location in 2016. This project will add an extra lane to the toll plaza. HNTB Corporation recommends that this location be re-evaluated in the future to determine safety impacts the extra toll lane will have at this exit.
Total number of crashes: 8, CRF: 1.43

9. Exit 36 Toll Plaza to I-195 Exit 1

This section is described as I-195 from the Exit 36 toll plaza to I-195 Exit 1 for a distance of 0.18miles. This section covers eastbound traffic. Five of the nine crashes are rear end or sideswipe crashes involving vehicles exiting I-195 at Exit 1. Seven of the nine crashes occur during the evening rush hour when traffic sometimes backs up onto the I-195 mainline.

HNTB Corporation recommends evaluating whether the capacity of the Exit 1 off ramp can be increased through the use of additional lanes or signal modifications. Pavement marking changes on I-195 EB to create a merge for traffic coming from the I-95 northbound off-ramp may reduce

sideswipe crashes due to eliminating the lane change currently needed for the large amount of traffic coming from I-95 SB that is headed toward Exit 1.
Total number of crashes: 9 CRF: 1.57

10. Turnpike Approach Maine Mall on Ramp to Exit 45 Toll Plaza

This brief section of highway encompasses the area from the Turnpike Approach Maine Mall on Ramp to the Exit 45 Toll Plaza. This section covers westbound traffic only. All twelve of the crashes are rear end or sideswipe crashes. The majority of the crashes are when vehicles stopped to merge onto the turnpike approach are rear ended by on ramp traffic. Nine of the twelve crashes occur during the weekday evening rush hour.

HNTB Corporation recommends considering lane configuration changes at Exit 45 whenever the toll plaza is due for major improvements, including changes that may be needed as part of a possible Gorham Toll Road project. Additionally, the Authority should also consider additional clearing on the inside of the Maine Mall Road Ramp to improve sight distance.
Total number of crashes 12 CRF: 3.29

The detailed collision diagrams for each of these locations can be found in Appendix D. These diagrams provide extensive details concerning each crash that occurs at these high crash locations.

8 COST ANALYSIS

Previous sections of this study identified a timeline when the Turnpike mainline segments and ramps would reach capacity. The timeline for capacity improvements could be hastened depending on the impacts of potential commercial developments, as well as the results of other ongoing studies, especially the Gorham East-West Corridor Feasibility Study.

As a result of the forecasted capacity needs, widening projects and cost for those projects were developed for the timelines established. When computing future costs for construction a few key assumptions were made:

- Construction costs and schedules are for the year that a segment, ramp or merge/diverge area reaches a LOS F.
- The cost to add a single lane to either a mainline or ramp in the year 2015 is $2,400,000/mile. Major items for adding a lane considered include clearing, pavement/gravel template, removing the existing shoulder, guardrail, stone ditch protection, loam, pavement markings, mobilization, median guardrail, ROW fence, traffic maintenance, common excavation, common borrow, and rock excavation. The total was then increased by a factor of 15% to account for miscellaneous costs involved with this type of large scale project.
- Ramp widening will add a 12' lane and a 10' shoulder.
- Ramps being widened to 2 lanes are to be lengthened 400' beyond their current length.
- The mainline widening will add 24' to the existing roadway.
- A conservative 3% inflation factor per year is implemented when forecasting future costs.
- All bridges South of Mile 44 have been designed to handle a mainline widening to four lanes and are not being considered for any replacement or repairs in this study.

Construction of each improvement would ideally begin before the year that an area reaches a failing Level of Service (LOS F). Planning and permitting should start for these projects when they reach a LOS E. These years have been calculated for each merge/diverge area, ramp and mainline segment and are presented in the tables within Sections 3, 4, and 5. The following cost calculations are based on the year that a given area is expected to reach LOS F. The construction schedule and forecasted costs are adjusted further to help reduce construction costs by grouping similar projects in adjoining locations in the same year. Table 7-1 displays proposed improvements which would alleviate the inadequate levels of service expected to be produced by forecasted volumes.

In the right hand column of Table 7-1, the total estimated costs of each improvement necessary to create a passing level of service is displayed. It is important to remember that these costs are summarized for the year during which construction is recommended to begin. The actual construction of various improvements may be spread out over more than one construction season.

In general, mainline sections for the northbound travel direction reach capacity several years before the southbound travel direction due to higher design hour volumes. The actual years that directional mainline widening is forecasted is shown in Table 7-1. However, the northbound and southbound sections would likely be permitted and constructed at the same time at a time when both sections reach capacity.

Table 8-1 – Forecasted Problems and Cost of Improvements

Year of Failure (LOS F)	Exit #/ Segment mileage	Location	Reason for failure	Necessary Improvement	Length of Improvement Area (miles)	Cost of Improvement in 2015	Forecasted Cost of Improvement for Year in Question	Necessary Bridge Expansion?	Cost of Bridges in 2012	Forecasted Cost of Bridges for Year in Question	Total Forecasted Cost
2025	0-2	NB Mainline	Mainline Capacity	Mainline Widening[1]	1.1	$2,640,000	$3,547,900	1 NB side of Overpass[2]	$2,000,000	$2,937,100	$6,485,000
2022	36	NB On Ramp	Ramp Capacity	Ramp Widening	0.76	$1,824,000	$2,243,300	NO			$2,243,300
2031	0-2	SB Mainline	Mainline Capacity	Mainline Widening[1]	1.1	$2,640,000	$4,236,400	1 SB side of Overpass[2]	$2,000,000	$3,507,000	$7,743,400
2016[4]	44	SB On-Ramp	Ramp Capacity	Ramp Widening	0.42	$1,008,000	$1,038,200	NO			$1,038,200
2023	46-48	NB Mainline	Mainline Capacity	Mainline Widening	2.1	$5,040,000	$6,384,500	2 Overpass; 1-side only[3]	$6,000,000	$8,305,400	$14,690,000
2032	36	SB Off Ramp	Ramp Capacity	Ramp Widening	0.84	$2,016,000	$3,332,100	NO			$3,332,100
2028	44-46	NB Mainline	Mainline Capacity	Mainline Widening	2.1	$5,040,000	$7,401,400	2 Underpass[3]	$17,400,000	$27,922,000	$35,323,000
2021	32	SB Off Ramp	Ramp Capacity	Ramp Widening	0.83	$1,992,000	$2,378,600	1	$2,000,000	$2,609,500	$4,988,100
2032	44-48	SB Mainline	Mainline Capacity	Mainline Widening	4.2	$10,08,000	$16,661000	2 carried in NB; 1 here[3]	$3,400,000	$6,140,800	$18,042,000
2033	36-42	SB Mainline	Mainline Capacity	Mainline Widening	6.8	$16,320,000	$27,784,000	NO			$27,784,000
2034	48-52	NB Mainline	Mainline Capacity	Mainline Widening	3.1	$7,440,000	$13,046,000	5 NB[3]	$20,800,857	$39,857,000	$52,903,000
2026	32	NB On Ramp	Ramp Capacity	Ramp Widening	0.38	$907,900	$1,256,700	NO			$1,256,700

[1]Traffic between Exits 0-7 is constrained by the Piscataqua River Bridge. Peak hour northbound traffic will not reach forecasted levels due to the traffic capacity constraint of the bridge. Conversely, peak hour traffic southbound will not benefit from widening if the capacity of the bridge is less than the mainline (i.e. if the bridge is not widened). Because of capacity issues, coordination with the New Hampshire Department of Transportation and the Maine Department of Transportation who jointly own the bridge will be needed in the near future.

[2]The widening of the bridge over the Piscataqua River is not included in this analysis.

[3]Bridges from MM 44-52 may need work sooner if part of the bridge program.

[4]This project is not funded in the current 30-year plan until 2023.

9 RECOMMENDATIONS/SUMMARY OF FINDINGS

This study assessed operating conditions of all interchanges, mainline sections, and ramps, on the Turnpike between Kittery and Augusta. This study also included an assessment of high crash locations for all mainline sections, ramps, toll plazas, and intersections of local roads with Turnpike ramps.

CAPACITY IMPROVEMENTS

Capacity improvements, presented in Table 8-1, are based on the results of the analyses performed and associated costs for each improvement by year. Included in Table 8-1are possible future improvements, an approximate time table of when the improvements will become necessary, and an estimate of the forecasted construction costs. HNTB Corporation has adjusted the construction schedule and costs previously presented to create an optimal timeline which will minimize construction costs by grouping similar projects in adjacent areas. The costs are shown in the LOS F year for information only. To summarize for budgeting purposes Table 8-1 combines the cost of all projects proposed to begin in the same year. Actual years of construction and costs of proposed work need to be studied and other MTA planning materials may show differently due to traffic control needs, contracting analysis, coordination with other projects, permitting needs, funding availability and other issues.

Table 9-1 – Cost of Proposed Improvements by Year

Year	Total Forecasted Cost	Location of Proposed Improvement
2016	$ 1,038,200	Exit 44 I-295 Scarborough SB On-Ramp
2021	$ 4,621,900	Exit 36 Saco – NB On-Ramp **and** Exit 32 Biddeford SB Off-Ramp
2023	$ 14,690,000	Jetport to Westbrook – NB Mainline
2025[1]	$ 14,228,400	NH State Line to Kittery Exit 2 – SB Mainline **and** NB Mainline
2026	$ 36,229,880	I-295 Scarborough to Jetport – NB Mainline **and** Exit 32 Biddeford – NB on-ramp
2032	$ 102,061,100	Exit 36 Saco to Exit 42 Scarborough – SB Mainline, I-295 Scarborough to Exit 48 Westbrook – SB Mainline, Exit 48 Westbrook to Exit 52 Falmouth – NB Mainline, **and** Exit 36 SB Off-Ramp

[1]Traffic between Exits 1-7 is constrained by the Piscataqua River Bridge. Peak hour northbound traffic will not reach forecasted levels due to the traffic capacity constraint of the bridge. Conversely, peak hour traffic southbound will not benefit from widening if the capacity of the bridge is less than the mainline (i.e. if the bridge is not widened). Because of capacity issues, coordination with the New Hampshire Department of Transportation and the Maine Department of Transportation who jointly own the bridge will be needed in the near future.

It should be noted that proposed mainline improvements in the Portland Area in 2023, 2026, and 2032 should be further evaluated as a single, comprehensive project. Any mainline or ramp capacity- adding projects will require the appropriate permitting and public processes as directed by law.

HIGH CRASH LOCATIONS

Improvements that could be considered to improve high crash locations are the following:

- Install a "Reduced Speed Limit when Flashing" sign just south of the Saco River Bridge in the NB direction.
- Include the locations south of the Hurricane Rd. bridge in the NB direction, and north of the Falmouth-Cumberland town line in the NB direction in the Authority's review of large animal collisions
- Add a Roadway Weather Information Station to provide advance warning and roadway condition monitoring during storms (near Piscataqua River Bridge and on York River Bridge).
- Consider additional cameras on the section of Turnpike near Exit 1.
- Evaluate whether the capacity of the I-195 Exit 1 off ramp can be increased through the use of additional lanes or signal modifications.
- Consider pavement marking changes on I-195 EB to create a merge for traffic coming from the I-95 northbound off-ramp.
- Consider alternative tolling strategies at Exit 45 that would separate Maine Mall Rd. vehicles from SR-703 WB vehicles.
- Consider additional clearing on Maine Mall Road ramp to improve sight distance.

A point of considerable interest, which arose during the research for this study, is the possible need for improvements that would involve the need for advanced planning with MaineDOT and local municipalities. These include, but are not limited to:

- Capacity needs on the Piscataqua River Bridge (also includes New Hampshire Department of Transportation)
- Improvements being considered on I-195 Exit 1 (part of Saco/Biddeford studies)
- Improvements being considered for Maine Mall Road ramp traffic (including improvements to the toll plaza and interchange bridge and potential changes to accommodate a Gorham Connector)

OTHER STUDIES

Outside of the course of this study, specific projects and issues have been identified that are being analyzed separately. They include the following studies:

- Relocation of the York Toll Plaza (MM 7.3)
- Gorham East-West Corridor Feasibility Study

The results of these studies could influence the timeline for capacity improvements on the Turnpike.

Appendix A Level of Service Description

TABLE 1-1. TYPES OF FACILITIES

FACILITY	CHAPTER
Uninterrupted Flow Facilities	
Freeways	
Basic freeway segments	3
Weaving areas	4
Ramps and ramp junctions	5
Freeway systems	6
Multilane Highways	7
Two-Lane Highways	8
Interrupted Flow Facilities	
Signalized Intersections	9
Unsignalized Intersections (2-way STOP-YIELD-controlled approaches; 4-way STOP-controlled intersections)	10
Arterials	11
Transit	12
Pedestrians	13
Bicycles	14

essary to examine points of fixed interruption as well as uninterrupted flow segments.

Pedestrian and transit flows are generally considered to be interrupted. Uninterrupted flow can exist under certain circumstances, such as in a long busway without stops or a long pedestrian corridor.

CAPACITY AND LEVEL-OF-SERVICE CONCEPTS

A principal objective of capacity analysis is the estimation of the maximum amount of traffic that can be accommodated by a given facility. Capacity analysis would, however, be of limited utility if this were its only focus. Traffic facilities generally operate poorly at or near capacity, and facilities are rarely designed or planned to operate in this range. Capacity analysis is also intended to estimate the maximum amount of traffic that can be accommodated by a facility while maintaining prescribed operational qualities.

Capacity analysis is, therefore, a set of procedures used to estimate the traffic-carrying ability of facilities over a range of defined operational conditions. It provides tools for the analysis and improvement of existing facilities, and for the planning and design of future facilities.

The definition of operational criteria is accomplished using *levels of service.* Ranges of operating conditions are defined for each type of facility, and are related to amounts of traffic that can be accommodated at each level.

The following sections present and define the two principal concepts of this manual: *capacity* and *level of service.*

Capacity

In general, the *capacity* of a facility is defined as the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions.

The *time period* used in most capacity analysis is 15-min, which is considered to be the shortest interval during which stable flow exists.

Capacity is defined for *prevailing roadway, traffic, and control conditions,* which should be reasonably uniform for any section of facility analyzed. Any change in the prevailing conditions will result in a change in the capacity of the facility. The definition of capacity assumes that good weather and pavement conditions exist.

1. *Roadway conditions*—Roadway conditions refer to the geometric characteristics of the street or highway, including: the type of facility and its development environment, the number of lanes (by direction), lane and shoulder widths, lateral clearances, design speed, and horizontal and vertical alignments.
2. *Traffic conditions*—Traffic conditions refer to the characteristics of the traffic stream using the facility. This is defined by the distribution of vehicle types in the traffic stream, the amount and distribution of traffic in available lanes of a facility, and the directional distribution of traffic.
3. *Control conditions*—Control conditions refer to the types and specific design of control devices and traffic regulations present on a given facility. The location, type, and timing of traffic signals are critical control conditions affecting capacity. Other important controls include STOP and YIELD signs, lane use restrictions, turn restrictions, and similar measures.

These and other factors affecting capacity are discussed in greater detail in a subsequent section of this chapter.

It is also important to note that *capacity* refers to a *rate* of vehicular or person flow during a specified period of interest, which is most often a peak 15-min. period. This recognizes the potential for substantial variations in flow during an hour, and focuses analysis on intervals of maximum flow.

Levels of Service

The concept of *levels of service* is defined as a qualitative measure describing operational conditions within a traffic stream, and their perception by motorists and/or passengers. A level-of-service definition generally describes these conditions in terms of such factors as speed and travel time, freedom to maneuver, traffic interruptions, comfort and convenience, and safety.

Six levels of service are defined for each type of facility for which analysis procedures are available. They are given letter designations, from A to F, with level-of-service A representing the best operating conditions and level-of-service F the worst.

1. *Level-of-service definitions*—In general, the various levels of service are defined as follows for uninterrupted flow facilities:

- *Level-of-service A* represents free flow. Individual users are virtually unaffected by the presence of others in the traffic stream. Freedom to select desired speeds and to maneuver within the traffic stream is extremely high. The general level of comfort and convenience provided to the motorist, passenger, or pedestrian is excellent.
- *Level-of-service B* is in the range of stable flow, but the presence of other users in the traffic stream begins to be noticeable. Freedom to select desired speeds is relatively unaffected, but there is a slight decline in the freedom to maneuver within the traffic stream from LOS A. The level of comfort and convenience provided is somewhat less than at LOS A, because the presence of others in the traffic stream begins to affect individual behavior.

• *Level-of-service C* is in the range of stable flow, but marks the beginning of the range of flow in which the operation of individual users becomes significantly affected by interactions with others in the traffic stream. The selection of speed is now affected by the presence of others, and maneuvering within the traffic stream requires substantial vigilance on the part of the user. The general level of comfort and convenience declines noticeably at this level.

• *Level-of-service D* represents high-density, but stable, flow. Speed and freedom to maneuver are severely restricted, and the driver or pedestrian experiences a generally poor level of comfort and convenience. Small increases in traffic flow will generally cause operational problems at this level.

• *Level-of-service E* represents operating conditions at or near the capacity level. All speeds are reduced to a low, but relatively uniform value. Freedom to maneuver within the traffic stream is extremely difficult, and it is generally accomplished by forcing a vehicle or pedestrian to "give way" to accommodate such maneuvers. Comfort and convenience levels are extremely poor, and driver or pedestrian frustration is generally high. Operations at this level are usually unstable, because small increases in flow or minor perturbations within the traffic stream will cause breakdowns.

• *Level-of-service F* is used to define forced or breakdown flow. This condition exists wherever the amount of traffic approaching a point exceeds the amount which can traverse the point. Queues form behind such locations. Operations within the queue are characterized by stop-and-go waves, and they are extremely unstable. Vehicles may progress at reasonable speeds for several hundred feet or more, then be required to stop in a cyclic fashion. Level-of-service F is used to describe the operating conditions within the queue, as well as the point of the breakdown. It should be noted, however, that in many cases operating conditions of vehicles or pedestrians discharged from the queue may be quite good. Nevertheless, it is the point at which arrival flow exceeds discharge flow which causes the queue to form, and level-of-service F is an appropriate designation for such points.

These definitions are general and conceptual in nature, and they apply primarily to uninterrupted flow. Levels of service for interrupted flow facilities vary widely in terms of both the user's perception of service quality and the operational variables used to describe them. Each chapter of the manual contains more detailed descriptions of the levels of service as defined for each facility type.

2. *Service flow rates*—The procedures of this manual attempt to establish or predict the maximum rate of flow which can be accommodated by various facilities at each level of service, except level-of-service F, for which flows are unstable. Thus, each facility has five service flow rates, one for each level of service (A through E), defined as follows.

The *service flow rate* is the maximum hourly rate at which persons or vehicles can reasonably be expected to traverse a point or uniform section of a lane or roadway during a given time period under prevailing roadway, traffic, and control conditions while maintaining a designated level of service. As to capacity, the service flow rate is generally taken for a 15-min time period.

Note that service flow rates are discrete values, while the levels of service represent a range of conditions. Because the service flow rates are defined as maximums for each level of service, they effectively define flow boundaries between the various levels of service.

3. *Measures of effectiveness*—For each type of facility, levels of service are defined based on one or more operational parameters which best describe operating quality for the subject facility type. While the concept of level of service attempts to address a wide range of operating conditions, limitations on data collection and availability make it impractical to treat the full range of operational parameters for every type of facility. The parameters selected to define levels of service for each facility type are called "measures of effectiveness," and represent those available measures that best describe the quality of operation on the subject facility type. Table 1-2 gives the measures of effectiveness used to define levels of service for each facility type.

Each level of service represents a range of conditions, as defined by a range in the parameter(s) given in Table 1-2. Thus, a level of service is not a discrete condition, but rather a range of conditions for which boundaries are established.

TABLE 1-2. MEASURES OF EFFECTIVENESS FOR LEVEL OF SERVICE DEFINITION

TYPE OF FACILITY	MEASURE OF EFFECTIVENESS
Freeways	
Basic freeway segments	Density (pc/mi/ln)
Weaving areas	Average travel speed (mph)
Ramp junctions	Flow rates (pcph)
Multilane Highways	Density (pc/mi/ln)
Two-Lane Highways	Percent time delay (%) Average travel speed (mph)
Signalized Intersections	Average individual stopped delay (sec/veh)
Unsignalized Intersections	Reserve capacity (pcph)
Arterials	Average travel speed (mph)
Transit	Load factor (pers/seat)
Pedestrians	Space (sq ft/ped)

BASIC PRINCIPLES OF TRAFFIC FLOW

Traffic Flow Measures

The operational state of any given traffic stream is defined by three primary measures:

1. Speed.
2. Volume and/or rate of flow.
3. Density.

1. *Speed* is defined as a rate of motion expressed as distance per unit time, generally as miles per hour (mph) or kilometers per hour (km/h). In characterizing the speed of a traffic stream, some representative value must be used, as there is generally a broad distribution of individual speeds that may be observed in the traffic stream. For the purposes of this manual, the speed measure used is *average travel speed.* This measure is used because it is easily computed from observation of individual vehicles within the traffic stream, and because it is the most statistically relevant measure in relationships with other varia-

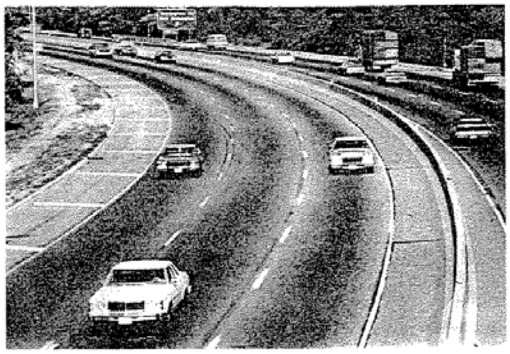


Illustration 3-5. Level-of-service A.

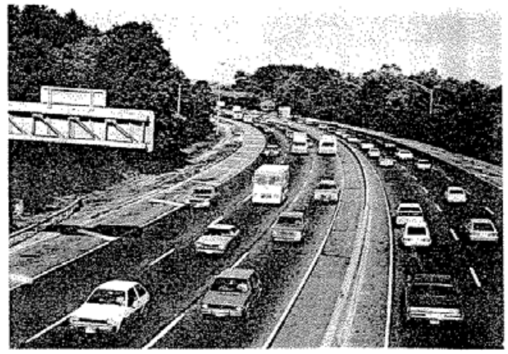


Illustration 3-8. Level-of-service D.

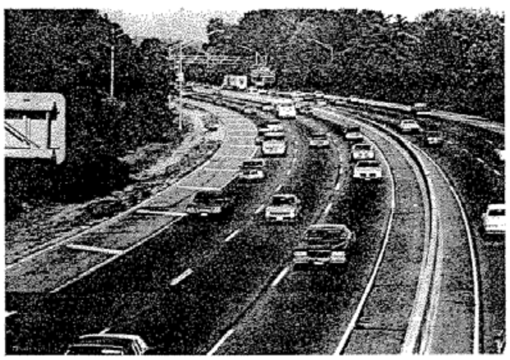


Illustration 3-6. Level-of-service B.

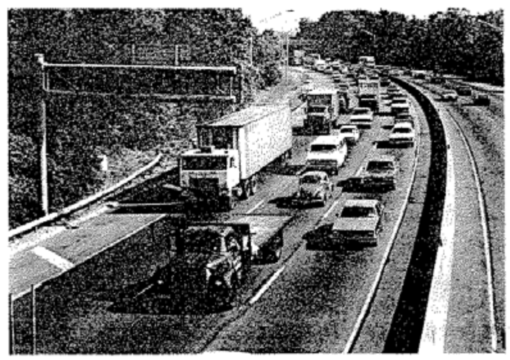


Illustration 3-9. Level-of-service E.

Illustration 3-7. Level-of-service C.

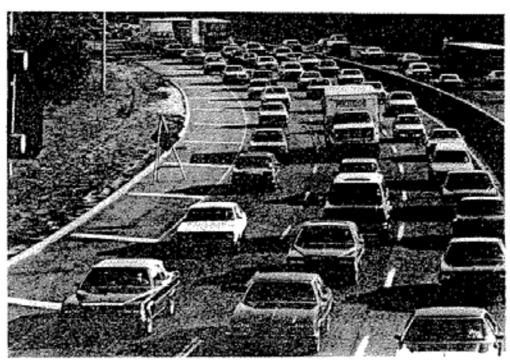


Illustration 3-10. Level-of-service F.

LOS information referenced from the Highway Capacity Manual.

Appendix B Non-Typical Diverge Calculations

Non-Typical Diverge Case: Exit 44

See pg. 13-27 of Highway Capacity Manual
Equation 13-27:

$$Dmd=.0175*(Vf/N)$$

Mainline's 30th Hour Analysis

INPUT	OUTPUT
Vf=3,919	Dmd=22.9
N=3	**LOS: C** – per Exhibit 13-2, page 13-4 of HCM

Appendix C Forecasted Volumes & LOS

Table C-1 summarizes the projected traffic volumes at all merge locations in the study area.

Table C-1 – Forecasted Volumes: Merge Areas

		NB-On				SB-On			
Location	**Seg-ment**	**10 years (2024)**		**20 years (2034)**		**10 years (2024)**		**20 years (2034)**	
		Ramp Pk.	ML Pk.	Ramp Pk.	ML Pk.	Ramp Pk.	ML Pk.	Ramp Pk.	ML Pk.
Kittery	*Ramp*	N/A				ML Pk.	*241*	ML Pk.	*280*
Exit 1	ML					Controls	5,762	Controls	6,687
Kittery	*Ramp*	N/A				ML Pk.	*1,682*	ML Pk.	*1,952*
Exit 2	ML					Controls	5,521	Controls	6,408
Kittery	*Ramp*	ML Pk.	*788*	ML Pk.	*915*	N/A			
Exit 3	ML	Controls	4,976	Controls	5,775				
York	*Ramp*	ML Pk.	*369*	ML Pk.	*428*	ML Pk.	*1,170*	ML Pk.	*1,358*
Exit 7	ML	Controls	4,301	Controls	4,991	Controls	5,031	Controls	5,839
Wells	*Ramp*	*585*	*482*	*679*	*559*	ML Pk.	*584*	ML Pk.	*677*
Exit 19	ML	1,736	4,123	2,015	4,785	Controls	4,374	Controls	5,076
Kennebunk	*Ramp*	*620*	*311*	*719*	*361*	ML Pk.	*295*	ML Pk.	*342*
Exit 25	ML	2,098	3,853	2,435	4,472	Controls	4,226	Controls	4,904
Biddeford	*Ramp*	*1,593*	*1,028*	*1,849*	*1,193*	*291*	*232*	*338*	*269*
Exit 32	ML	3,344	4,538	3,880	5,266	2,963	3,869	3,439	4,490
Saco	*Ramp*	ML Pk.	*1,689*	ML Pk.	*1,960*	*841*	*689*	*976*	*800*
Exit 36	ML	Controls	4,638	Controls	5,383	3,371	4,459	3,913	5,175
Scarborough	*Ramp*	*339*	*305*	*393*	*354*	ML Pk.	*475*	ML Pk.	*551*
Exit 42	ML	3,920	4,548	4,550	5,278	Controls	4,851	Controls	5,630
I-295	*Ramp*	N/A				ML Pk.	*1,910*	ML Pk.	*2,217*
Exit 44	ML					Controls	4,759	Controls	5,523
S. Portland	*Ramp*	ML Pk.	*885*	ML Pk.	*1,028*	ML Pk.	*794*	ML Pk.	*921*
Exit 45	ML	Controls	2,870	Controls	3,331	Controls	3,156	Controls	3,663
Jetport	*Ramp*	ML Pk.	*1,055*	ML Pk.	*1,224*	ML Pk.	*585*	ML Pk.	*679*
Exit 46	ML	Controls	3,576	Controls	4,150	Controls	3,015	Controls	3,499
Rand Road	*Ramp*	*245*	*207*	*284*	*240*	ML Pk.	*406*	ML Pk.	*471*
Exit 47	ML	1,900	3,359	2,205	3,898	Controls	3,196	Controls	3,709
Riverside	*Ramp*	ML Pk.	*573*	ML Pk.	*665*	ML Pk.	*708*	ML Pk.	*822*
Exit 48	ML	Controls	3,107	Controls	3,606	Controls	2,991	Controls	3,471
Falmouth	*Ramp*	ML Pk.	*272*	ML Pk.	*315*	*771*	*681*	*894*	*791*
Exit 52	ML	Controls	2,607	Controls	3,025	1,967	2,755	2,283	3,197
W. Falmouth	*Ramp*	*315*	*302*	*365*	*350*	ML Pk.	*839*	ML Pk.	*974*
Exit 53	ML	1,850	2,063	2,147	2,395	Controls	2,343	Controls	2,719
Gray	*Ramp*	ML Pk.	*839*	ML Pk.	*900*	ML Pk.	*187*	ML Pk.	*209*
Exit 63	ML	Controls	2,343	Controls	2,513	Controls	1,215	Controls	1,355
Auburn	*Ramp*	*258*	*187*	*287*	*209*	*258*	*1,081*	*287*	*1,206*
Exit 75	ML	918	1,215	1,024	1,355	918	1,997	1,024	2,228
Lewiston	*Ramp*	ML Pk.	*1,081*	ML Pk.	*1,206*	ML Pk.	*532*	ML Pk.	*594*
Exit 80	ML	Controls	1,997	Controls	2,228	Controls	1,155	Controls	1,288

It is important to keep the following in mind when reviewing the preceding table:

- *Ramp Pk.* indicates the ramp and mainline volumes associated with the 30th highest hour on the ramp. Similarly, *ML Pk.* indicates the ramp and mainline volumes associated with the 30th highest hour on the mainline.
- The *ML* volume is inclusive of the merging ramp volume.
- The phrase "ML Pk. Controls" indicates that both the ramp volume and the mainline volume associated with the "ML Pk." condition are greater than the volumes associated with the "Ramp Pk." condition.

Future year volumes are based on the existing condition volumes with an assumed growth rate of 0.5%, 1.6%, 1.5%, or 1.1% depending on the location as mentioned in the report. The formula used to calculate the future volumes was:

$$V_f = V_c * (1+g)^T$$

Where:

- V_f = Forecasted Volume
- V_c = Current Volume (2014 data)
- g = annual growth rate for segment in question
- T = Year in question (10 or 20 years from 2014)

Table C-2 shows the future LOS values for each merge area based on the predicted volumes.

Table C-2 – Forecasted LOS: Merge Areas

Location	NB-On				SB-On			
	10 Years (2024)		20 Years (2034)		10 Years (2024)		20 Years (2034)	
	Ramp	ML	Ramp	ML	Ramp	ML	Ramp	ML
Kittery *Exit 1*	N/A				ML Pk. Controls	F	ML Pk. Controls	F
Kittery *Exit 2*	N/A				ML Pk. Controls	E	ML Pk. Controls	F
Kittery *Exit 3*	ML Pk. Controls	D	ML Pk. Controls	F	N/A			
York *Exit 7*	ML Pk. Controls	D	ML Pk. Controls	D	ML Pk. Controls	E	ML Pk. Controls	F
Wells *Exit 19*	B	C	B	D	ML Pk. Controls	D	ML Pk. Controls	D
Kennebunk *Exit 25*	B	C	B	C	ML Pk. Controls	C	ML Pk. Controls	C
Biddeford *Exit 32*	C	D	C	D	B	C	B	C
Saco *Exit 36*	ML Pk. Controls	D	ML Pk. Controls	E	C	C	C	D
Scarborough *Exit 42*	C	D	D	D	ML Pk. Controls	D	ML Pk. Controls	E
I-295 *Exit 44*	N/A				ML Pk. Controls	E	ML Pk. Controls	F
S. Portland *Exit 45*	ML Pk. Controls	D	ML Pk. Controls	D	ML Pk. Controls	D	ML Pk. Controls	F
Jetport *Exit 46*	ML Pk. Controls	D	ML Pk. Controls	F	ML Pk. Controls	D	ML Pk. Controls	D
Rand Road *Exit 47*	B	D	B	F	ML Pk. Controls	D	ML Pk. Controls	F
Riverside *Exit 48*	ML Pk. Controls	D	ML Pk. Controls	E	ML Pk. Controls	D	ML Pk. Controls	D
Falmouth *Exit 52*	ML Pk. Controls	C	ML Pk. Controls	D	B	C	C	D
W. Falmouth *Exit 53*	B	B	B	C	ML Pk. Controls	C	ML Pk. Controls	C
Gray *Exit 63*	B	B	B	B	ML Pk. Controls	C	ML Pk. Controls	C
Auburn *Exit 75*	ML Pk. Controls	B	ML Pk. Controls	B	A	A	A	A
Lewiston *Exit 80*	ML Pk. Controls	A	ML Pk. Controls	A	ML Pk. Controls	A	ML Pk. Controls	A

Table C-3 summarizes the projected traffic volumes at all diverge locations in the study area. As with Table C-1, some explanatory notes are in order:

- *Ramp Pk.* indicates the ramp and mainline volumes associated with the 30th highest hour on the ramp. Similarly, *ML Pk.* indicates the ramp and mainline volumes associated with the 30th highest hour on the mainline.

- The *ML* volume is inclusive of the diverging ramp volume. In other words, the "Ramp" volume is a subset of the "ML" volume.
- The phrase "ML Pk. Controls" indicates that both the ramp volume and the mainline volume associated with the "ML Pk." condition are greater than the volumes associated with the "Ramp Pk." condition.

As with the merge volumes, all diverging volumes were based on the existing (2014) volumes observed on the Turnpike. Future year volumes are based on the existing condition volumes with an assumed growth rate of 0.5%, 1.6%, 1.5%, or 1.1% depending on the location as mentioned in the report. Future volumes were calculated using the formula:

$$V_f = V_c*(1+g)^T$$

Where:

- V_f = Forecasted Volume
- V_c = Current Volume (2014 data)
- g = annual growth rate for segment in question
- T = Year in question (10 or 20 years from 2014)

Table C-3 – Forecasted Volumes: Diverge Areas

Location	Segment	NB-Off				SB-Off			
		10 years (2024)		20 years (2034)		10 years (2024)		20 years (2034)	
		Ramp Pk.	ML Pk.	Ramp Pk.	ML Pk.	Ramp Pk.	ML Pk.	Ramp Pk.	ML Pk.
Kittery	Ramp	ML Pk. Controls	349	ML Pk. Controls	405	N/A			
Exit 1	ML		5,972		6,931				
Kittery	Ramp	ML Pk. Controls	505	ML Pk. Controls	586	ML Pk. Controls	534	ML Pk. Controls	620
Exit 2	ML		5,623		6,526		5,031		5,839
Kittery	Ramp	ML Pk. Controls	1,098	ML Pk. Controls	1,274	N/A			
Exit 3	ML		5,119		5,941				
York	Ramp	ML Pk. Controls	1,142	ML Pk. Controls	1,325	ML Pk. Controls	467	ML Pk. Controls	541
Exit 7	ML		4,976		5,775		4,374		5,076
Wells	Ramp	ML Pk. Controls	737	ML Pk. Controls	855	514	319	319	370
Exit 19	ML		4,301		4,991	2,609	4,226	4,226	4,904
Kennebunk	Ramp	ML Pk. Controls	317	ML Pk. Controls	368	574	310	310	360
Exit 25	ML		4,123		4,785	2,937	3,869	3,869	4,490
Biddeford	Ramp	361	308	419	357	ML Pk. Controls	1,660	ML Pk. Controls	1,926
Exit 32	ML	3,222	3,853	3,739	4,472		4,459		5,175
Saco	Ramp	767	700	890	812	ML Pk. Controls	1,460	ML Pk. Controls	1,694
Exit 36	ML	4,142	4,538	4,807	5,266		4,851		5,630
Scarborough	Ramp	440	388	510	450	ML Pk. Controls	377	ML Pk. Controls	438
Exit 42	ML	3,822	4,638	4,435	5,383		4,759		5,523
I-295	Ramp	1,620	1,234	1,880	1,432	N/A			
Exit 44	ML	4,249	4,548	4,931	5,278				
S. Portland	Ramp	ML Pk. Controls	1,246	ML Pk. Controls	1,447	874	620	1,014	719
Exit 45	ML		3,247		3,769	2,200	3,015	2,554	3,499
Jetport	Ramp	709	258	258	299	ML Pk. Controls	1,126	ML Pk. Controls	1,306
Exit 46	ML	2,593	2,870	2,870	3,331		3,196		3,709
Rand Road	Ramp	ML Pk. Controls	468	ML Pk. Controls	543	ML Pk. Controls	186	ML Pk. Controls	215
Exit 47	ML		3,576		4,150		2,991		3,471
Riverside	Ramp	ML Pk. Controls	751	ML Pk. Controls	871	ML Pk. Controls	554	ML Pk. Controls	642
Exit 48	ML		3,359		3,898		2,755		3,197
Falmouth	Ramp	ML Pk. Controls	522	ML Pk. Controls	605	ML Pk. Controls	304	ML Pk. Controls	353
Exit 52	ML		3,107		3,606		2,343		2,719
W. Falmouth	Ramp	ML Pk. Controls	751	ML Pk. Controls	871	ML Pk. Controls	350	ML Pk. Controls	407
Exit 53	ML		2,607		3,025		2,077		2,411
Gray	Ramp	ML Pk. Controls	987	ML Pk. Controls	1.101	250	202	279	225
Exit 63	ML		1,984		2,213	1,015	1,084	1,133	1,210
Auburn	Ramp	ML Pk. Controls	570	ML Pk. Controls	636	ML Pk. Controls	501	ML Pk. Controls	559
Exit 75	ML		1,215		1,355		1,064		1,187
Lewiston	Ramp	ML Pk. Controls	520	ML Pk. Controls	580	283	116	316	129
Exit 80	ML		1,155		1,288	717	805	800	899

Table C-4 shows the future LOS values for each merge area based on the predicted volumes.

Table C-4 – Forecasted LOS: Diverge Areas

Location	NB-Off				SB-Off			
	10 Years (2024)		20 Years (2034)		10 Years (2024)		20 Years (2034)	
	Ramp	ML	Ramp	ML	Ramp	ML	Ramp	ML
Kittery *Exit 1*	ML Pk. Controls	F	ML Pk. Controls	F	N/A			
Kittery *Exit 2*	ML Pk. Controls	F	ML Pk. Controls	F	ML Pk. Controls	D	ML Pk. Controls	F
Kittery *Exit 3*	ML Pk. Controls	E	ML Pk. Controls	F	N/A			
York *Exit 7*	ML Pk. Controls	E	ML Pk. Controls	F	ML Pk. Controls	D	ML Pk. Controls	E
Wells *Exit 19*	ML Pk. Controls	C	ML Pk. Controls	D	C	D	C	D
Kennebunk *Exit 25*	ML Pk. Controls	C	ML Pk. Controls	C	B	C	C	C
Biddeford *Exit 32*	C	C	C	D	ML Pk. Controls	F	ML Pk. Controls	F
Saco *Exit 36*	D	F	F	F	ML Pk. Controls	E	ML Pk. Controls	F
Scarborough *Exit 42*	D	D	D	E	ML Pk. Controls	D	ML Pk. Controls	E
I-295 *Exit 44*					N/A			
S. Portland *Exit 45*	ML Pk. Controls	E	ML Pk. Controls	F	B	C	C	D
Jetport *Exit 46*	C	D	D	E	ML Pk. Controls	D	ML Pk. Controls	F
Rand Road *Exit 47*	ML Pk. Controls	E	ML Pk. Controls	F	ML Pk. Controls	D	ML Pk. Controls	E
Riverside *Exit 48*	ML Pk. Controls	D	ML Pk. Controls	F	ML Pk. Controls	C	ML Pk. Controls	D
Falmouth *Exit 52*	ML Pk. Controls	D	ML Pk. Controls	D	ML Pk. Controls	C	ML Pk. Controls	C
W. Falmouth *Exit 53*	ML Pk. Controls	C	ML Pk. Controls	D	ML Pk. Controls	B	ML Pk. Controls	C
Gray *Exit 63*	ML Pk. Controls	B	ML Pk. Controls	B	A	A	A	A
Auburn *Exit 75*	ML Pk. Controls	A	ML Pk. Controls	A	ML Pk. Controls	A	ML Pk. Controls	A
Lewiston *Exit 80*	ML Pk. Controls	A	ML Pk. Controls	A	A	A	A	A

The volumes used in the analysis of the Turnpike mainline are summarized in

Table C-5.

Table C-5 – Forecasted Volumes: Mainline Areas

Location	Segment	Northbound		Southbound	
		10 years (2024)	20 years (2034)	10 years (2024)	20 years (2034)
NH Border to Exit 1, Kittery	0 to 1	5,409	5,686	5,219	5,486
Exit 1 to Exit 2, Kittery	1 to 2	5,093	5,354	5,001	5,257
Kittery to York	2 to 7	4,507	4,738	4,557	4,790
York to Wells	7 to 19	4,301	4,991	4,374	5,076
Wells to Kennebunk	19 to 25	4,123	4,785	4,226	4,904
Kennebunk to Biddeford	25 to 32	3,853	4,472	3,869	4,490
Biddeford to Saco	32 to 36	4,583	5,371	4,503	5,278
Saco to Scarborough	36 to 42	4,684	5,490	4,899	5,742
Scarborough to I-295	42 to 44	4,548	5,278	4,759	5,523
I-295 to South Portland	44 to 45	3,247	3,769	3,156	3,663
South Portland to Jetport	45 to 46	2,870	3,331	3,015	3,499
Jetport to Rand Road	46 to 47	3,576	4,150	3,196	3,709
Rand Road to Riverside	47 to 48	3,359	3,898	2,991	3,471
Riverside to Falmouth	48 to 52	3,107	3,606	2,755	3,197
Falmouth to West Falmouth	52 to 53	2,607	3,025	2,343	2,719
West Falmouth to Gray	53 to 63	1,984	2,213	1,997	2,228
Gray to Auburn	63 to 75	1,215	1,355	1,084	1,210
Auburn to Lewiston	75 to 80	1,155	1,288	1,064	1,187

Table C-5 shows the 'worst case scenario volumes'. Volumes were predicted using the annual growth rate of 0.5%, 1.6%, 1.5%, or 1.1% depending on the location as mentioned in the report and were calculated using the compounding interest formula:

$$V_f = V_c*(1+g)^T$$

Where:

- V_f=Forecasted Volume
- V_c=Current Volume (2014 data)
- g=annual growth rate for segment in question
- T=Year in question (10 or 20 years from 2014)

Table C-6 shows the future LOS values for each merge area based on the predicted volumes.

Table C-6 – Forecasted LOS: Mainline Areas

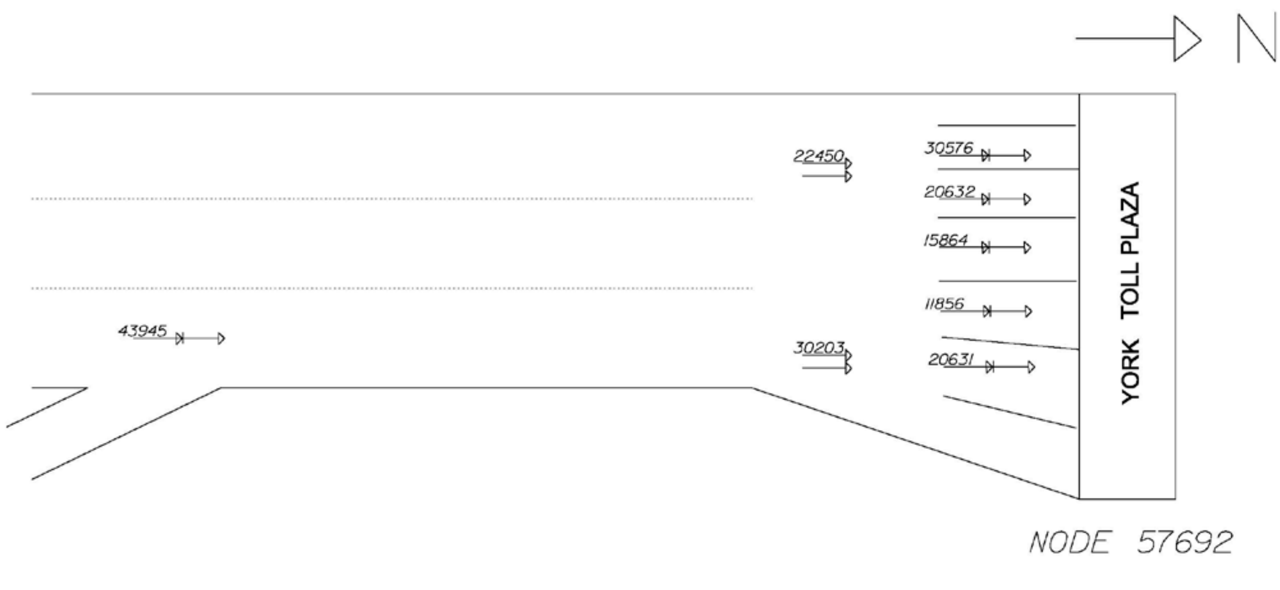
Location	Segment	NB 10-year	NB 20-year	SB 10-year	SB 20-year
NH Border to Exit 1, Kittery	0-1	E	F	E	F
Exit 1 to Exit 2, Kittery	1-2	E	E	E	E
NH Border to York	2-7	D	D	D	D
York to Wells	7-19	D	E	D	E
Wells to Kennebunk	19-25	D	D	D	D
Kennebunk to Biddeford	25-32	C	D	C	D
Biddeford to Saco	32-36	D	E	D	E
Saco to Scarborough	36-42	D	E	D	F
Scarborough to I-295	42-44	D	E	D	E
I-295 to South Portland	44-45	E	F	E	F
South Portland to Jetport	45-46	D	E	D	E
Jetport to Rand Road	46-47	E	F	E	F
Rand Road to Riverside	47-48	E	F	D	E
Riverside to Falmouth	48-52	D	E	D	E
Falmouth to West Falmouth	52-53	C	D	C	D
West Falmouth to Gray	53-63	C	C	C	C
Gray to Auburn	63-75	B	B	A	A
Auburn to Lewiston	75-80	A	B	A	A

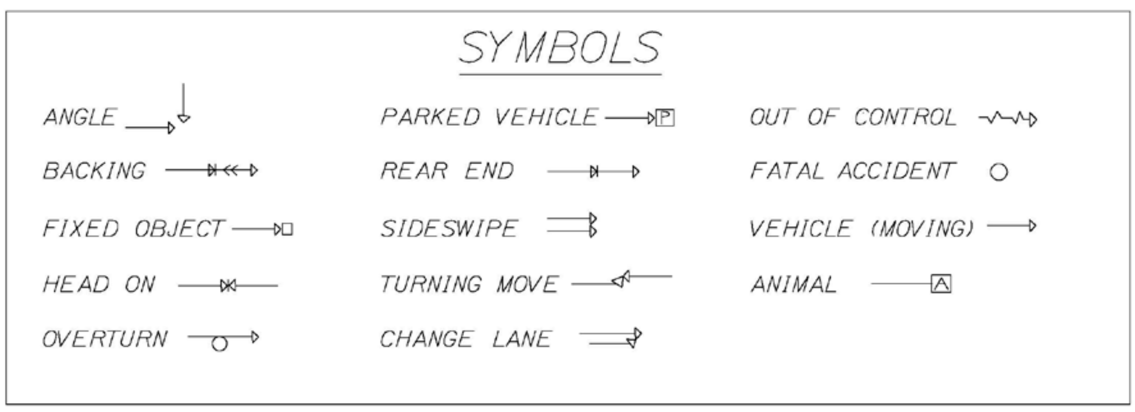
Appendix D High Crash Location Diagrams

SEGMENT LENGTH: N/A
NUMBER OF CRASHES: 8
CRASH RATE FACTOR: 3.27

NODE: 57692
MILE MARKER: 7.19 NB
LOCATION: YORK TOLL PLAZA

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA





NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
43945	11/12/2012	Mon	13:24	Other	Rear End/Sideswipe		
11856	5/9/2013	Thu	15:51	Other	Rear End/Sideswipe		
15864	6/29/2013	Sat	6:45	Other	Rear End/Sideswipe		
20631	8/9/2013	Fri	20:40	Other	Rear End/Sideswipe		
20632	8/11/2013	Sun	10:30	Other	Rear End/Sideswipe		
30203	11/23/2013	Sat	15:51	Other	Rear End/Sideswipe		
22450	8/14/2014	Thu	11:11	Other	Rear End/Sideswipe		
30576	11/6/2014	Thu	20:25	Other	Rear End/Sideswipe		

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
43945	None	Daylight	Clear	Dry	Level	No	10
11856	Other	Daylight	Cloudy	Wet	Level	No	10
15864	Advisory/Warning Sign	Daylight	Cloudy	Wet	Level	No	10
20631	Advisory/Warning Sign	Dark - Lighted	Cloudy	Wet	On Grade	No	10
20632	Advisory/Warning Sign	Daylight	Clear	Dry	On Grade	No	10
30203	Other	Daylight	Clear	Dry	On Grade	No	10
22450	Other	Daylight	Clear	Dry	On Grade	No	10
30576	None	Dark - Lighted	Rain	Wet	Level	No	10

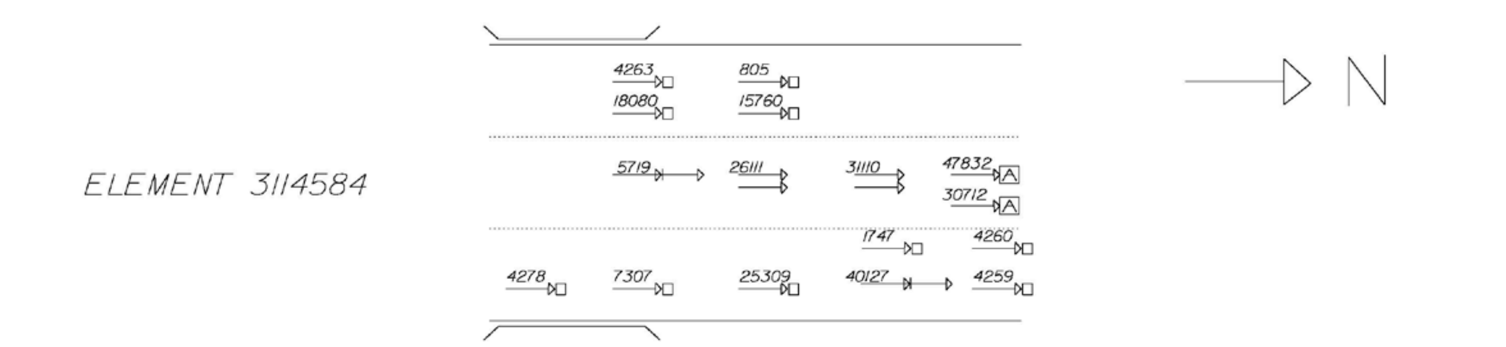
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
43945	Changing Lanes, Merging	None, None	Motor vehicle in Transport
11856	Changing Lanes, Stopped in Traffic, Stopped in Traffic, Following Roadway	None, None, None, None	Motor vehicle in Transport
15864	Other Vehicle Action (distracted), Following Roadway, Stopped in Traffic	None, None, None	Motor vehicle in Transport
20631	Following Roadway, Following Roadway	None, None	Motor vehicle in Transport
20632	Starting in Traffic, Stopped in Traffic	None, None	Motor vehicle in Transport
30203	Changing Lanes, Following Roadway	None, None	Motor vehicle in Transport
22450	Merging, Following Roadway	None, None	Motor vehicle in Transport
30576	Following Roadway, Following Roadway	None, None	Motor vehicle in Transport

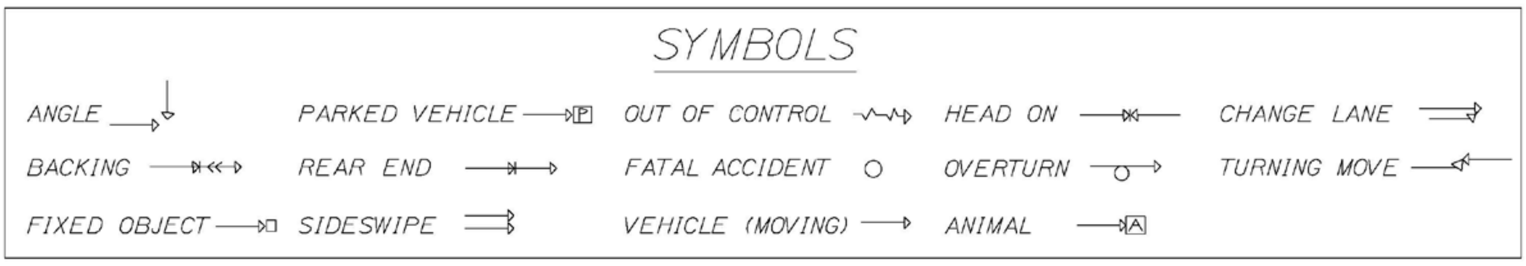
NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
43945	Apparently Normal, Apparently Normal	Followed to Closely & Exceeded Speed Limit, No Contributing Action	5,5
11856	Apparently Normal, Apparently Normal, Apparently Normal, Apparently Normal	Failed to Yield Right-of-Way, No Contributing Action, No Contributing Action, No Contributing Action	5,5,5,5,5,5
15864	Under influence of Medications/Drugs/Alcohol, Apparently Normal, Apparently Normal	Failed to Yield Right-of-Way, No Contributing Action, No Contributing Action	5,5,4,5
20631	Apparently Normal, Apparently Normal	Failed to Yield Right-of-Way & Failed to Keep in Proper Lane, No Contributing Action	5,5,5
20632	Apparently Normal, Apparently Normal	No Contributing Action, Followed to Closely	5,5,5,5,5
30203	Apparently Normal, Apparently Normal	Failed to Yield Right-of-Way, No Contributing Action	5,5,5,5,5
22450	Apparently Normal, Apparently Normal	Other Contributing Action, No Contributing Action	5,5,5,5,5
30576	Under influence of Medications/Drugs/Alcohol, Apparently Normal	Followed Too Closely & Drove Too Fast For Conditions, No Contributing Action	5,5,5

SEGMENT LENGTH: 0.38
NUMBER OF CRASHES: 16
CRASH RATE FACTOR: 1.05

ELEMENT: 3114584
MILE MARKER: 32.60 NB
LOCATION: TL - BIDDEFORD, SACO TO BRG 1342, I-95 UNDER BOOM RD

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA





NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
805	1/12/2012	Thu	10:30	Straight Road	Went off Road	Guardrail	
25309	3/26/2012	Mon	8:30	Straight Road	Went off Road	Guardrail	
31110	6/22/2012	Fri	18:30	Straight Road	Rear End/Sideswipe		
40127	9/28/2012	Fri	21:00	Straight Road	Rear End/Sideswipe		
47832	12/19/2012	Wed	18:00	Straight Road	Rear End/Sideswipe	Deer	
4259	2/10/2013	Sun	19:28	Curved Road	Went off Road	Guardrail	
4260	2/10/2013	Sun	20:15	Curved Road	Went off Road	Snow Bank	
4263	2/11/2013	Mon	18:27	Bridges	Other	Bridge Rail	
7307	3/16/2013	Sat	1:00	Bridges	Other	Bridge Rail	
15760	7/1/2013	Mon	13:15	Straight Road	Went off Road	Guardrail	
26111	10/21/2013	Mon	19:43	Bridges	Rear End/Sideswipe		
1747	1/15/2014	Wed	7:55	Curved Road	Object in Road	Truck Tire Debris	
4278	2/2/2014	Sun	11:02	Straight Road	Went off Road	Guardrail	
5719	2/18/2014	Tue	17:17	Curved Road	Rear End/Sideswipe		
18080	6/1/2014	Sun	7:11	Curved Road	Went off Road	Guardrail, tree	
30712	11/9/2014	Sun	17:15	Straight Road	Deer	Deer	

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
805	None	Daylight	Snow	Snow	Level	No	70
25309	None	Daylight	Cloudy	Dry	Level	Yes	55
31110	None	Daylight	Clear	Dry	On Grade	no	70
40127	None	Dark - Not Lighted	Rain	Wet	Level	no	70
47832	None	Dark - Not Lighted	Cloudy	Dry	On Grade	no	70
4259	None	Dark - Not Lighted	Clear	Snow	Level	no	70
4260	None	Dark - Not Lighted	Clear	Snow	Level	no	70
4263	Advisory/Warning Sign	Dark - Not Lighted	Cloudy	Ice/Frost	Level	no	70
7307	Advisory/Warning Sign	Dark - Not Lighted	Cloudy	Ice/Frost	Level	no	70
15760	None	Daylight	Rain	Wet	Level	no	70
26111	Advisory/Warning Sign	Dark - Not Lighted	Clear	Dry	Level	yes	55
1747	None	Daylight	Clear	Dry	Level	no	70
4278	None	Daylight	Cloudy	Dry	Level	no	70
5719	None	Dark - Not Lighted	Snow	Snow	Level	no	70
18080	None	Daylight	Clear	Dry	Level	no	70
30712	None	Dark - Not Lighted	Clear	Dry	On Grade	no	70

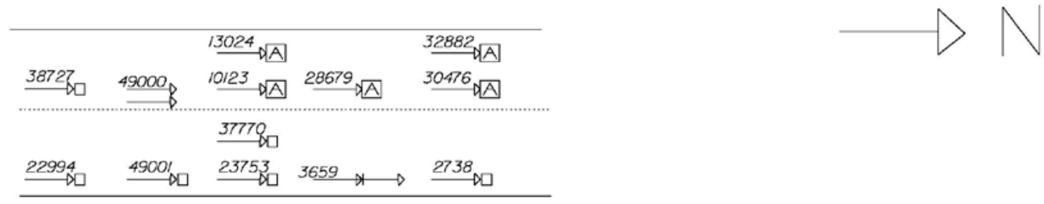
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
805	Following Roadway	None	Went off Roadway Left
25309	Backing	None	Motor Vehicle in Transport
31110	Changing Lanes, Following Roadway	None	Went off Roadway Left
40127	Slowing in Traffic, Following Roadway	None	Motor Vehicle in Transport
47832	Following Roadway	None	Animal
4259	Skidding	None	Went off Roadway Left, Embankment
4260	Skidding	None	Went off Roadway Left, Reentering Roadway
4263	Skidding	None	Went off Roadway Right
7307	Skidding	None	Bridge Rail
15760	Skidding	None	Motor Vehicle in Transport, Guardrail
26111	Merging, Slowing in Traffic	None	Motor Vehicle in Transport
1747	Following Roadway	Tires, none	Equipment Failure
4278	Following Roadway	None	Bridge Rail
5719	Changing Lanes, Overtaking Passing	None	Motor Vehicle in Transport
18080	Following Roadway	None	Went off Roadway Left, Right, Guardrail Face
30712	Following Roadway	None	Animal

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
805	Apparently Normal	Drove Too Fast For Conditions	5
25309	Apparently Normal	Improper Backing	5
31110	Apparently Normal	Failed to Keep Proper Lane	3,4,3,5,5,5
40127	Apparently Normal	Drove Too Fast For Conditions	5,5,3,5
47832	Apparently Normal	No Contributing Action, Swerved or Avoided Due to Wind, Slippery Surface, Motor Vehicle, Object, Non-Motorist in Road	5,5,5,5
4259	Apparently Normal	Exceeded Posted Speed Limit	4
4260	Apparently Normal	Drove Too Fast For Conditions	5
4263	Apparently Normal	Drove Too Fast For Conditions	4
7307	Apparently Normal	Drove Too Fast For Conditions	5
15760	Apparently Normal	Drove Too Fast For Conditions	5,3,3
26111	Apparently Normal	No Contributing Action	5,5,5,5
1747	Apparently Normal, Other	No Contributing Action	5,5,5
4278	Apparently Normal	Failed to Keep Proper Lane	3
5719	Apparently Normal	Drove Too Fast For Conditions	5,5
18080	Asleep or Fatigued	Failed to Keep Proper Lane	5
30712	Apparently Normal	No Contributing Action	5

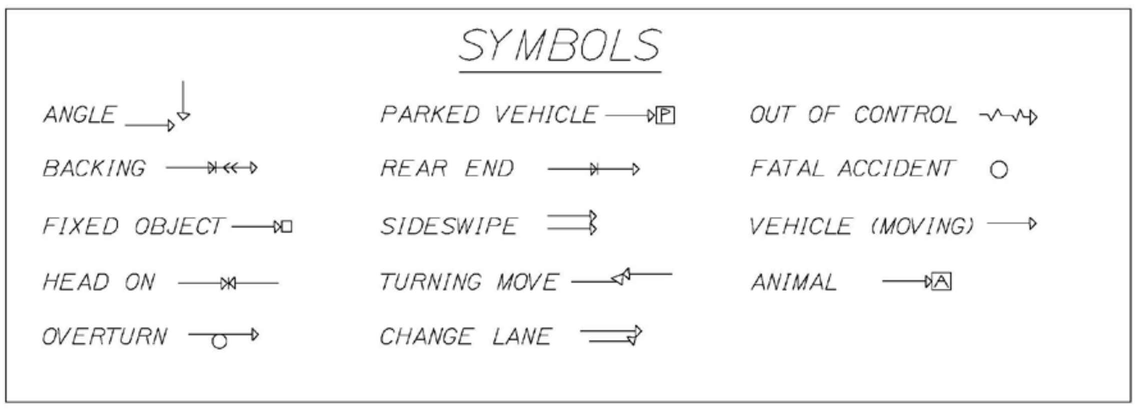
SEGMENT LENGTH: 0.43
NUMBER OF CRASHES: 13
CRASH RATE FACTOR: 1.58

ELEMENT: 3120767
MILE MARKER: 55.81 NB
LOCATION: BRG 0280, I-95 UNDER HURRICANE RD
TO TL - CUMBERLAND, FALMOUTH

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 3120767



NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
22994	2/24/2012	Fri	21:46	Straight Road	Went off Road	Guardrail	
38727	8/29/2012	Wed	20:38	Straight Road	Object in Road	Box Spring	
49000	12/25/2012	Tue	10:10	Straight Road	Rear End/Sideswip	Guardrail	
49001	12/25/2012	Tue	10:20	Straight Road	Went off Road	Culvert	
10123	4/20/2013	Sat	21:10	Straight Road	Moose	Moose	
13024	5/26/2013	Sun	21:11	Straight Road	Deer	Deer	
23753	8/24/2013	Sat	15:28	Straight Road	Thrown or Falling Object	Ladder	
28679	11/9/2013	Sat	0:02	Straight Road	Deer	Deer	
3659	1/16/2014	Thu	17:21	Straight Road	Rear End/Sideswipe		
2738	1/17/2014	Fri	15:50	Straight Road	Went off Road	Jersey Barrier	
30476	11/18/2014	Tue	21:20	Straight Road	Deer	Deer	
32882	11/26/2014	Wed	23:52	Straight Road	Deer	Deer	
37770	12/18/2014	Thu	1:18	Straight Road	Went off Road	Guardrail	

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
22994	Other	Dark - Not Lighted	Rain	Slush	Level	No	70
38727	None	Dark - Not Lighted	Clear	Dry	Level	No	70
49000	None	Daylight	Snow	Snow	On Grade	No	70
49001	Other	Daylight	Snow	Snow	On Grade	No	45
10123	None	Dark - Not Lighted	Clear	Dry	Bottom of Hill	No	70
13024	None	Dark - Not Lighted	Clear	Dry	Level	No	70
23753	None	Daylight	Clear	Dry	Level	No	70
28679	None	Dark - Not Lighted	Clear	Dry	Level	No	70
3659	Advisory/Warning Sign	Dark - Not Lighted	Clear	Wet	On Grade	Yes	45
2738	Advisory/Warning Sign	Daylight	Clear	Dry	Level	Yes	45
30476	None	Dark - Not Lighted	Clear	Dry	Level	No	70
32882	None	Dark - Not Lighted	Clear	Dry	Level	No	70
37770	None	Dark - Not Lighted	Rain	Wet	Level	No	70

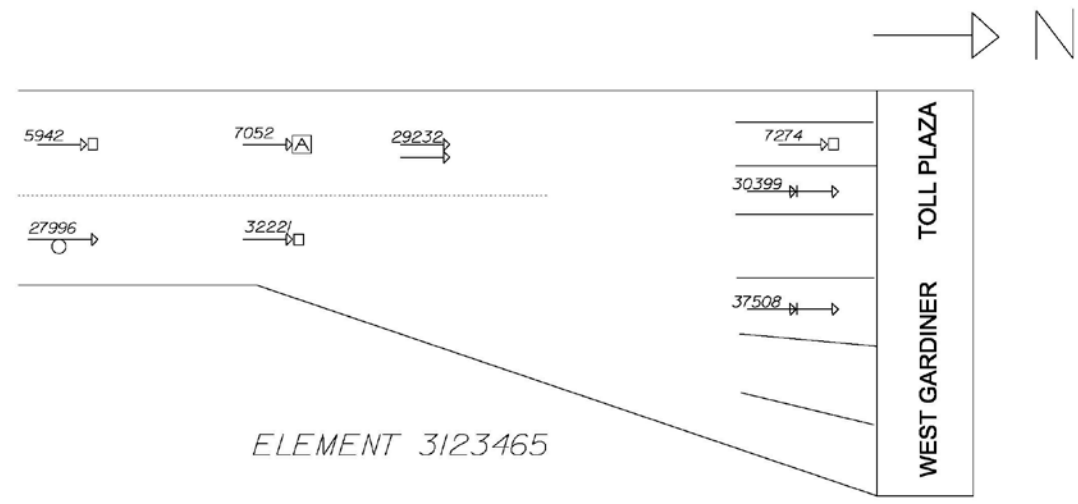
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
22994	Following Roadway	None	Went off Roadway Right, Guardrail
38727	Following Roadway	None	Struck by Falling, Shifting Cargo or Anything Set in Motion by Motor Vehicle
49000	Skidding, Following Roadway	None	Motor Vehicle In Transport, Motor Vehicle In Transport
49001	Skidding	None	Went off Roadway Right
10123	Following Roadway	None	Motor Vehicle In Transport, Animal
13024	Following Roadway	None	Animal
23753	Following Roadway, Following Roadway	None	Thrown or Falling Object
28679	Following Roadway	None	Animal
3659	Slowed in Traffic, Stopped in Traffic, Following Roadway	None	Motor Vehicle in Transport
2738	Avoided Vehicle, Object, Pedestrian, Animal in Roadway	None	Overturn/Rollover
30476	Following Roadway	None	Motor Vehicle in Transport
32882	Following Roadway	None	Animal
37770	Following Roadway	None	Went off Roadway Right, Embankment

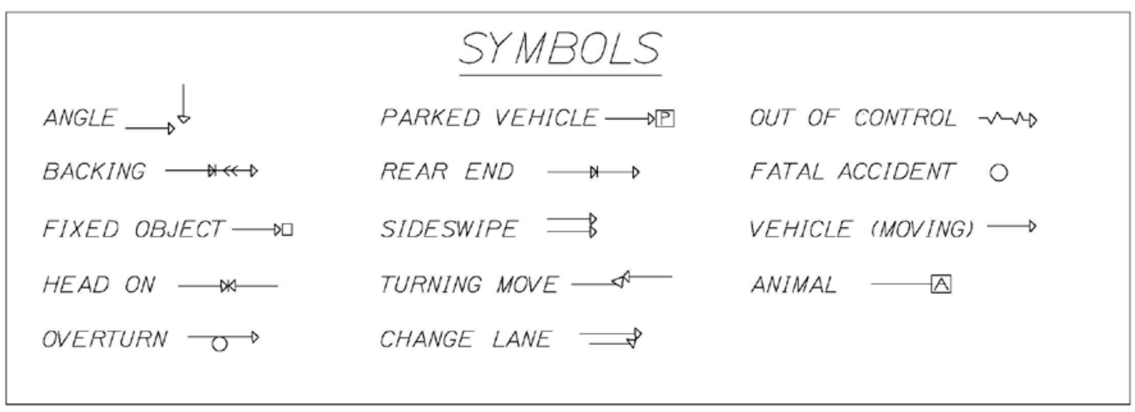
NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
22994	Apparently Normal	Drove Too Fast For Conditions	5
38727	Apparently Normal	No Contributing Action	5
49000	Apparently Normal	Drove Too Fast For Conditions	5,5,5,5
49001	Apparently Normal	Drove Too Fast For Conditions	5,5,5,5
10123	Apparently Normal	No Contributing Action	5,5
13024	Apparently Normal	No Contributing Action	5,5,5
23753	Apparently Normal	No Contributing Action	5,5
28679	Apparently Normal	No Contributing Action	5
3659	Apparently Normal	Followed too Closely, Drove Too Fast For Condititons	5,5,5,5
2738	Apparently Normal	Swerved or Avoided Due to Wind, Slippery Surface, Motor Vehicle, Object, Non-Motorist in Roadway	5,4
30476	Apparently Normal	No Contributing Action	4
32882	Apparently Normal	No Contributing Action	5,5
37770	Asleep or Fatigued	Ran off Roadway	5

SEGMENT LENGTH: 1.0
NUMBER OF CRASHES: 8
CRASH RATE FACTOR: 1.11

ELEMENT: 3123465
MILE MARKER: 97.81 NB
LOCATION: TL - LITCHFIELD, WEST GARDINER TO WEST GARDINER TOLL PLAZA

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA





NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
29232	5/21/2012	Monday	14:36	Straight Road	Rear End/Sideswipe		
5942	2/27/2013	Wednesday	21:30	Straight Road	Went off Road	Median Rail	
7274	3/18/2013	Monday	11:30	Other	Other	Toll Booth	
7052	3/1/2014	Saturday	22:30	Straight Road	Deer	Deer	
27996	10/14/2014	Tuesday	15:30	Straight Road	Went off Road	Guardrail	
30399	11/1/2014	Saturday	18:45	Straight Road	Rear End/Sideswipe		
32221	11/18/2014	Friday	4:49	Straight Road	Went off Road	Guardrail	
37508	12/18/2014	Thursday	22:00	Straight Road	Rear End/Sideswipe		

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
29232	Other	Daylight	Clear	Dry	Level	No	70
5942	None	Dark - Not Lighted	Snow	Snow	Level	No	70
7274	Trafic Signals (Flashing)	Daylight	Clear	Level	Level	No	10
7052	None	Dark - Not Lighted	Clear	Dry	Level	No	70
27996	None	Daylight	Clear	Dry	On Grade	No	70
30399	Trafic Signals (Stop & Go)	Dark - Lighted	Rain	Wet	Level	No	10
32221	None	Dark - Not Lighted	Cloudy	Ice/Frost	Level	No	70
37508	Advisory/Warning Sign	Dark - Lighted	Clear	Dry	Level	No	10

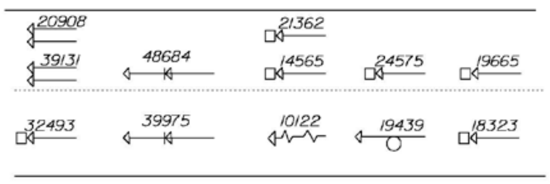
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
29232	Merging	None	Motor Vehicle in Transport
5942	Skidding	None	Motor Vehicle in Transport
7274	Slowing in Traffic	None	Other Fixed Oject (wall, building , tunnel)
7052	Following Roadway	None	Animal
27996	Following Roadway	Wheels	Went Off Roadway Left, Overturn/Rollover
30399	Other Vehicle Action	Brakes	Motor Vehicle in Transport
32221	Following Roadway	None	Guardrail End, Went of Roadway
37508	Following Roadway	None	Motor Vehicle in Transport

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
29232	Apparently Normal	Failed to Yield Right-of-Way, No Contributing Action	5,5
5942	Apparently Normal	Drove Too Fast for Conditions	5
7274	Apparently Normal	Other Contributing Action	5
7052	Apparently Normal	No Contributing Action	5
27996	Apparently Normal	No Contributing Action	3
30399	Apparently Normal	Exceeded Posted Speed Limit, No Contributing Action	5,5,4
32221	Apparently Normal	No Contributing Action	5
37508	Apparently Normal	Following Too Closely, No Contributing Action	5,5,5,4

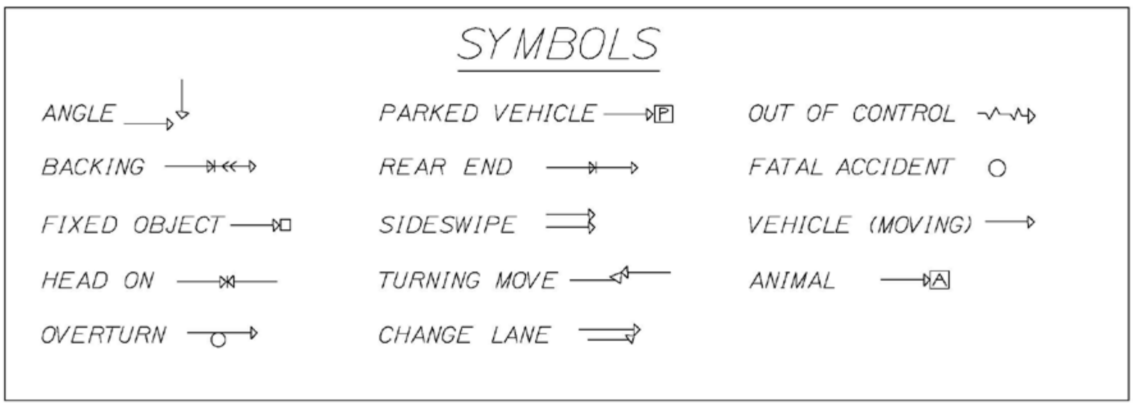
SEGMENT LENGTH: 0.41
NUMBER OF CRASHES: 12
CRASH RATE FACTOR: 1.20

ELEMENT: 3119831
MILE MARKER: 195.50 SB
LOCATION: INT I-95 TO TL - AUGUSTA, HALLOWELL

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 3119831



NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
32493	7/12/2012	Thu	17:01	Straight Road	Went Off Road	Guardrail	
39131	9/21/2012	Fri	10:56	Straight Road	Rear End/Sideswipe		
39975	9/27/2012	Thu	14:24	Straight Road	Rear End/Sideswipe		
48684	12/26/2012	Wed	11:40	Straight Road	Rear End/Sideswipe		
10122	4/20/2013	Sat	8:15	Straight Road	Went Off Road		
14565	6/7/2013	Fri	22:45	Straight Road	Went Off Road	Guardrail	
19439	8/9/2013	Fri	18:40	Straight Road	Went Off Road		
24575	9/7/2013	Sat	17:02	Straight Road	Went Off Road	Guardrail	
19665	7/2/2014	Wed	20:15	Straight Road	Went Off Road	Guardrail	
18323	7/4/2014	Fri	18:37	Straight Road	Went Off Road	Tree	
20908	7/27/2014	Sun	20:45	Straight Road	Rear End/Sideswipe		
21362	7/28/2014	Mon	13:15	Curved Road	Went Off Road	Guardrail	

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
32493	None	Daylight	Clear	Dry	Level	No	70
39131	None	Daylight	Clear	Dry	On Grade	Yes	45
39975	Advisory/Warning Signs	Daylight	Clear	Dry	Level	Yes	45
48684	None	Daylight	Clear	Dry	On Grade	No	70
10122	None	Daylight	Rain	Wet	Level	No	70
14565	None	Dark - Not Lighted	Rain	Wet	Level	No	70
19439	None	Daylight	Rain	Wet	Level	No	70
24575	None	Daylight	Cloudy	Dry	Level	No	70
19665	None	Dusk	Rain	Wet	Level	No	70
18323	Advisory/Warning Signs	Daylight	Rain	Water (Standing, Moving)	Level	No	70
20908	None	Dark - Not Lighted	Clear	Dry	Level	No	70
21362	None	Daylight	Rain	Wet	Level	No	70

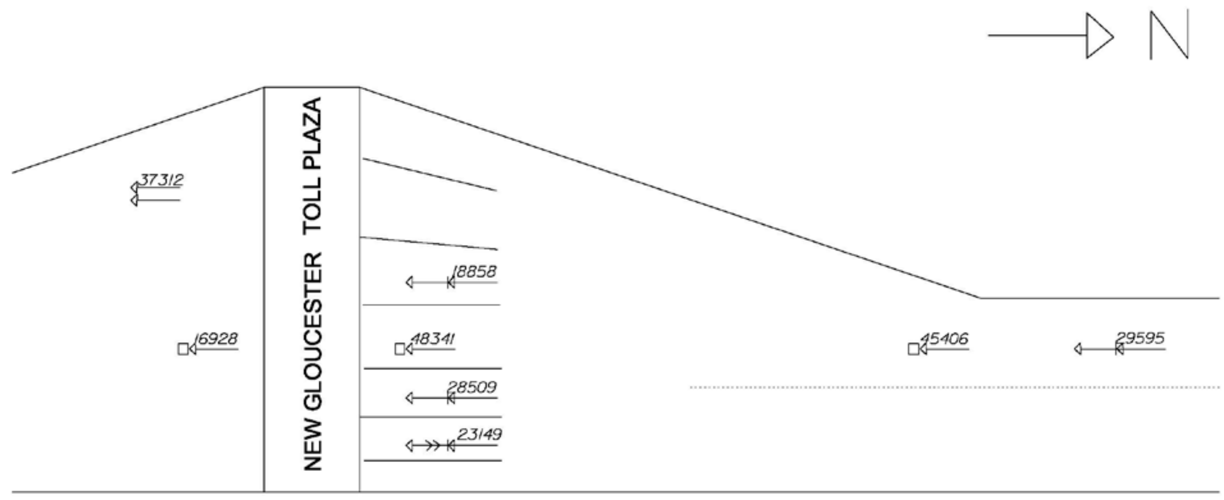
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
32493	Following Roadway	None	Went Off Roadway Left
39131	Changing Lanes	None	Motor Vehicle in Transport
39975	Stopped in Traffic, Slowing in Traffic	None	Motor Vehicle in Transport
48684	Following Roadway	None	Motor Vehicle in Transport
10122	Following Roadway	None	Went Off Roadway Right
14565	Following Roadway	None	Motor Vehicle in Transport
19439	Skidding	Tires	Went off Roadway Right
24575	Following Roadway	None	Went Off Roadway Left
19665	Overtaking Passing	None	Went Off Roadway Left
18323	Changing Lanes	None	Went Off Roadway Right
20908	Following Roadway	None	Motor Vehicle in Transport
21362	Following Roadway	None	Motor Vehicle in Transport, Went Off Roadway Left

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
32493	Asleep or Fatigued	Failed to Keep Proper Lane	4
39131	Apparently Normal	Failed to Yield Right-of-Way	5,5,5
39975	Apparently Normal	Drove to Fast for Conditions	5,5
48684	Apparently Normal	Followed Too Closely	5,2,5,5,5,5
10122	Apparently Normal	Drove too Fast for Conditions	3,5
14565	Apparently Normal	Drove too Fast for Conditions	5
19439	Apparently Normal	Drove too Fast for Conditions	5
24575	Apparently Normal	Ran Off Roadway	5,5
19665	Apparently Normal	Over-Correcting/Over Steering	5,5
18323	Apparently Normal	Drove too Fast for Conditions	5,5,5,5
20908	Apparently Normal	No Contributing Factor	5,5,5,5,5
21362	Apparently Normal	Drove too Fast for Conditions	5,5,5,5

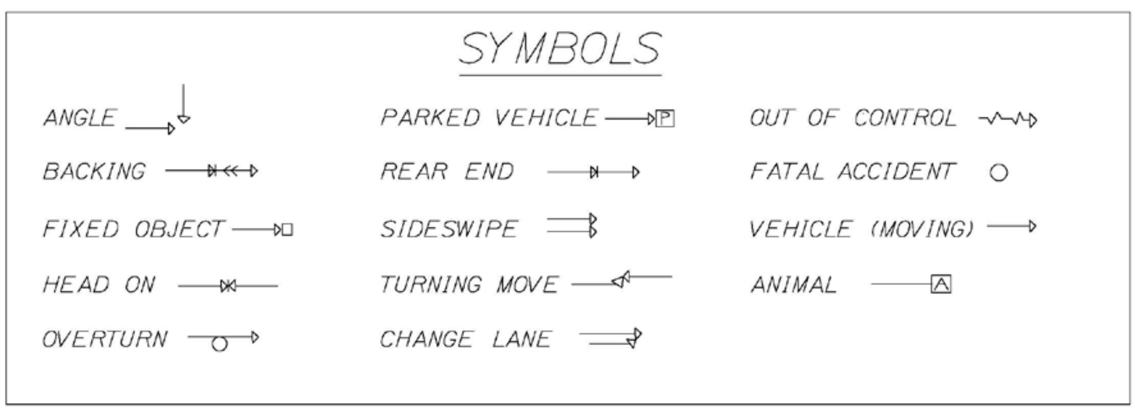
SEGMENT LENGTH: 0.49
NUMBER OF CRASHES: 8
CRASH RATE FACTOR: 1.15

ELEMENT: 3115776
MILE MARKER: 236.60 SB
LOCATION: TL - GRAY, NEW GLOUCESTER
TO BRG 0293, I-95 SB UNDER MAYALL RD

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 3115776



NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
23149	2/29/2012	Wed	7:45	Other	Rear End/Sideswipe		
29595	5/31/2012	Thu	9:37	Straight Road	Rear End/Sideswipe		
37312	8/13/2012	Mon	17:30	Other	Rear End/Sideswipe		
45406	11/18/2012	Sun	6:22	Straight Road	Went Off Road	Guardrail	
48341	12/1/2012	Sat	11:50	Other	Went Off Road	Concrete Barrier	
18858	7/20/2013	Sat	15:42	Other	Rear End/Sideswipe		
28509	11/12/2013	Tue	16:54	Other	Rear End/Sideswipe		
16928	6/22/2014	Sun	15:30	Other	Went Off Road	Electronic Payment Sign	Toll Vehicle Counting Device

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
23149	Other	Daylight	Clear	Dry	Level	No	10
29595	Advisory/Warning Sign	Daylight	Clear	Dry	Level	Yes	45
37312	Other	Daylight	Clear	Dry	Level	Yes	10
45406	None	Daylight	Clear	Dry	Level	No	70
48341	Advisory/Warning Sign	Daylight	Snow	Wet	Level	No	10
18858	Other	Daylight	Clear	Dry	Level	No	10
28509	Other	Dark-Lighted	Clear	Dry	Level	No	10
16928	Other	Daylight	Clear	Dry	Level	No	10

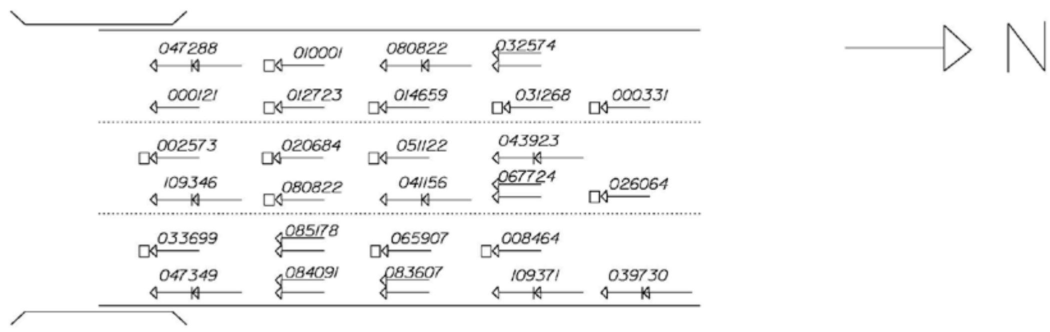
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
23149	Backing, Slowing in Traffic	None	Motor Vehicle in Transport
29595	Following Roadway, Slowing in Traffic	None	Motor Vehicle in Transport
37312	Starting in Traffic	None	Motor Vehicle in Transport
45406	Following Roadway	None	Went Off Roadway Left
48341	Slowed in Traffic	None	Concrete Traffic Barrier
18858	Slowing in Traffic, Stopped in Traffic	None	Motor Vehicle in Transport
28509	Parked Illegally, Following Roadway	None	Parked Motor Vehicle, Motor Vehicle in Transport
16928	Starting in Traffic	Power Train	Went Off Roadway Left

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
23149	Apparently Normal	Improper Backing	5,5
29595	Asleep or Fatigued, Apparently Normal	Operating Motor Vehicle in Erratic, Reckless, Careless. Negligent or Aggressive Manner	5,3
37312	Apparently Normal	Unknown	5,5
45406	Apparently Normal	Ran off Roadway	5,5
48341	Apparently Normal	Failed to Keep in Proper Lane, Drove Too Fast For Conditions	5
18858	Apparently Normal	Other Contributing Action	5,5,5
28509	Apparently Normal	Disregarded Other Traffic Sign, No Contributing Action	5,5,4,5
16928	Apparently Normal	Failed to Keep in Proper Lane, Ran off Roadway	5,5,5

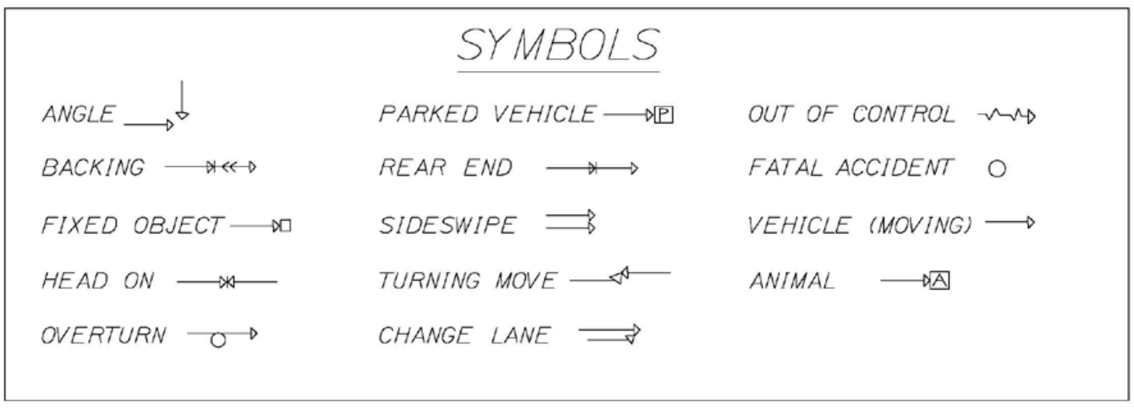
SEGMENT LENGTH: 0.55
NUMBER OF CRASHES: 26
CRASH RATE FACTOR: 1.10

ELEMENT: 3121414
MILE MARKER: 302.57 SB
LOCATION: SL - MAINE, NEW HAMPSHIRE TO EXIT 1

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 3121414



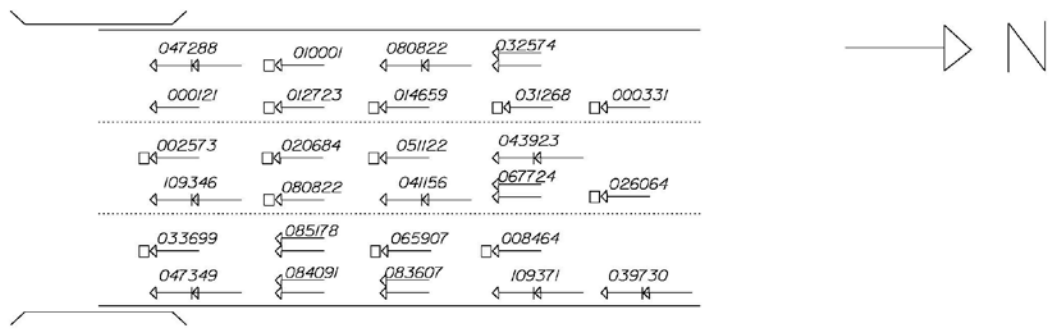
NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
010001	2/14/2012	Tue	5:50	Straight Road	Jackknife	Guardrail	
084091	11/16/2013	Sat	11:45	Straight Road	Rear End/Sideswipe		
080822	11/28/2012	Wed	7:15	Straight Road	Rear End/Sideswipe	Concrete Barrier	
012723	2/25/2012	Sat	15:00	Straight Road	Thrown or Falling Object		
014659	3/4/2012	Sun	15:55	Curved Road	Went Off Road	Guardrail	
083607	12/11/2012	Tue	3:24	Bridges	Head-on/Sideswipe	Jersey Barrier	
041156	6/3/2013	Mon	19:50	Other	Rear End/Sideswipe		
109346	12/7/2014	Sun	15:55	Straight Road	Rear End/Sideswipe		
109371	12/7/2014	Sun	17:20	Straight Road	Rear End/Sideswipe		
067724	9/9/2013	Mon	13:38	Straight Road	Rear End/Sideswipe		
031268	5/15/2012	Tue	21:59	Straight Road	Went Off Road	Guardrail	
047349	7/15/2012	Sun	18:05	Straight Road	Rear End/Sideswipe		
000121	1/1/2014	Wed	13:25	Straight Road	Other		
033699	4/24/2014	Thu	8:25	Straight Road	Went Off Road	Guardrail	
002573	1/10/2014	Fri	8:13	Bridges	Rear End/Sideswipe	Concrete Barrier	
080822	9/7/2014	Sun	11:35	Straight Road	Rear End/Sideswipe		
047288	7/15/2012	Sun	14:07	Straight Road	Rear End/Sideswipe		
051122	7/29/2012	Sun	5:20	Straight Road	Head-on/Sideswipe	Guardrail	
008464	1/16/2013	Wed	6:50	Straight Road	Went Off Road	Guardrail	
085178	9/21/2014	Sun	13:58	Straight Road	Rear End/Sideswipe		
032574	5/1/2013	Wed	9:30	Straight Road	Rear End/Sideswipe		
020684	3/13/2014	Thu	6:24	Straight Road	Went Off Road	Guardrail	
065907	9/23/2012	Sun	17:10	Bridges	Rear End/Sideswipe		
043923	5/26/2014	Mon	14:51	Straight Road	Rear End/Sideswipe		
039730	6/17/2012	Sun	17:13	Straight Road	Rear End/Sideswipe		
000331	1/2/2014	Thu	9:00	Straight Road	Went Off Road	Guardrail	
026064	3/31/2014	Mon	4:45	Straight Road	Went Off Road	Guardrail	

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
010001	None	Dark-Not Lighted	Clear	Dry	On Grade	No	55
084091	None	Daylight	Clear	Dry	Level	No	65
080822	None	Daylight	Snow	Ice/Frost	On Grade	No	65
012723	None	Daylight	Cloudy	Dry	On Grade	No	55
014659	None	Daylight	Clear	Dry	On Grade	No	55
083607	None	Dark-Lighted	Rain	Wet	On Grade	No	65
041156	Stop Signs (Other)	Dusk	Clear	Dry	Level	Yes	50
109346	None	Dusk	Clear	Dry	Level	No	65
109371	None	Dark-Lighted	Clear	Dry	Level	No	65
067724	Other	Daylight	Cloudy	Dry	Level	No	65
031268	None	Dark-Lighted	Rain	Wet	Level	No	55
047349	None	Daylight	Cloudy	Dry	Level	No	65
000121	None	Daylight	Clear	Dry	Level	No	65
033699	None	Daylight	Clear	Dry	Level	No	65
002573	None	Daylight	Snow	Snow	On Grade	No	65
080822	None	Daylight	Clear	Dry	Top of Hill	No	65
047288	None	Daylight	Clear	Dry	Top of Hill	No	65
051122	None	Dawn	Cloudy	Dry	Level	No	65
008464	Advisory/Warning Sign	Dawn	Snow	Snow	Level	No	45
085178	None	Daylight	Cloudy	Dry	On Grade	No	65
032574	None	Daylight	Clear	Dry	Level	No	65
020684	None	Dawn	Sleet, Hail (Freezing Rain or Drizzle)	Ice/Frost	On Grade	No	45
065907	None	Daylight	Clear	Dry	Top of Hill	No	65
043923	None	Daylight	Cloudy	Dry	On Grade	No	65
039730	None	Daylight	Clear	Dry	Level	No	65
000331	None	Daylight	Snow	Snow	Level	No	45
026064	None	Dark-Lighted	Sleet, Hail (Freezing Rain or Drizzle)	Slush	Level	No	65

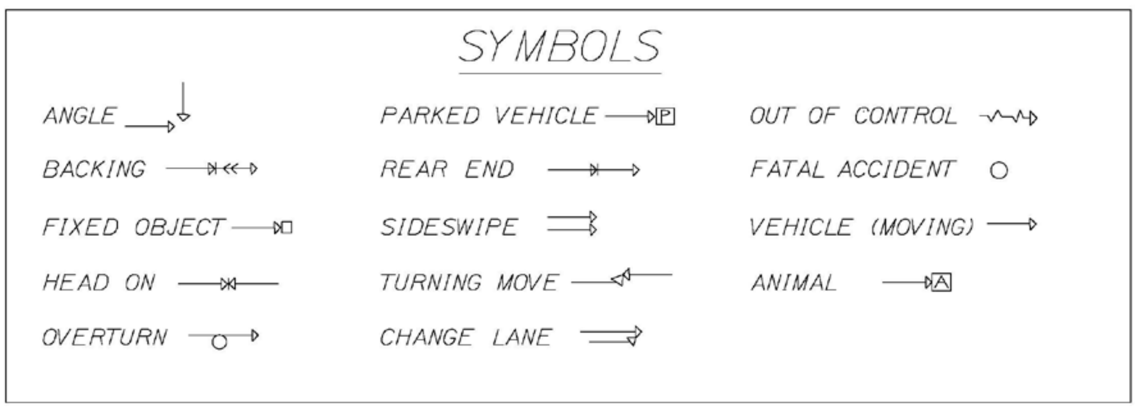
SEGMENT LENGTH: 0.55
NUMBER OF CRASHES: 26
CRASH RATE FACTOR: 1.10

ELEMENT: 3121414
MILE MARKER: 302.57 SB
LOCATION: SL - MAINE, NEW HAMPSHIRE TO EXIT 1

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 3121414 (CONTINUED)



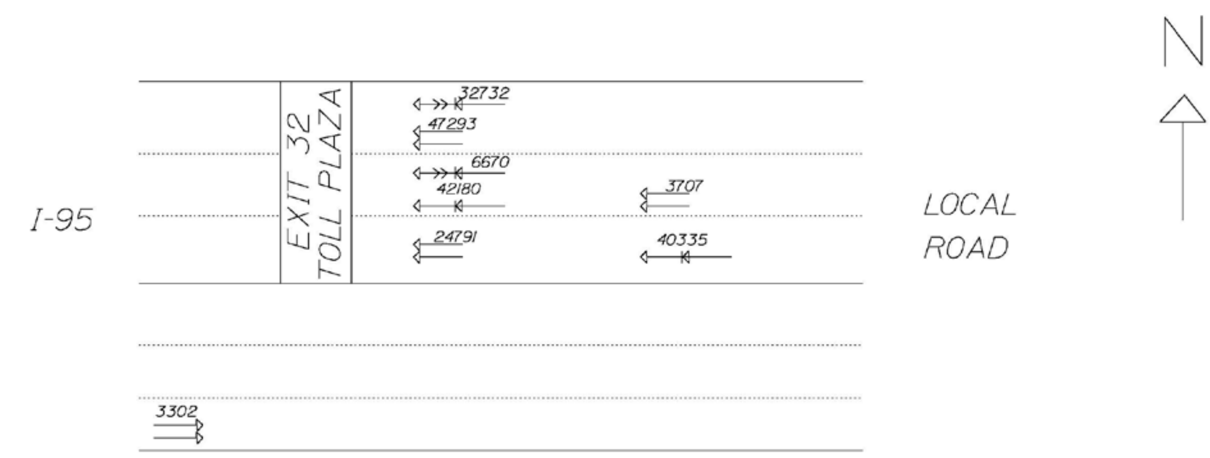
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
010001	Skidding	Other	Jackknife
084091	Making Left Turn, Following Roadway	Other, None	Motor Vehicle in Transport
080822	Skidding, Following Roadway	None	Went off Roadway Left, Motor Vehicle in Transport
012723	Following Roadway	None	Thrown or Falling Object
014659	Following Roadway	None	Went off Roadway Left
083607	Avoiding Vehicle Object, Pedestrian, Animal in Roadway	None	Motor Vehicle in Transport
041156	Started in Traffic	None	Motor Vehicle in Transport
109346	Slowing in Traffic	None	Motor Vehicle in Transport
109371	Following Roadway	None	Motor Vehicle in Transport
067724	Avoiding Vehicle Object, Pedestrian, Animal in Roadway, Skidding	None	Motor Vehicle in Transport
031268	Following Roadway	None	Went Off Roadway Left
047349	Following Roadway	None	Motor Vehicle in Transport
000121	Following Roadway	Other	Other, Non Collision
033699	Following Roadway	None	Went off Roadway Left
002573	Following Roadway	None	Went off Roadway Left
080822	Stopped in Traffic, Following Roadway	None	Motor Vehicle in Transport
047288	Slowing in Traffic, Stopped in Traffic	None	Motor Vehicle in Transport
051122	Following Roadway	None	Motor Vehicle in Transport
008464	Following Roadway	None	Went off Roadway Left
085178	Other Vehicle Action, Following Roadway	None	Motor Vehicle in Transport
032574	Overtaking Passing, Following Roadway	None	Motor Vehicle in Transport
020684	Following Roadway	None	Motor Vehicle in Transport
065907	Slowing in Traffic, Following Roadway	None	Motor Vehicle in Transport
043923	Skidding, Stopped in Traffic	None	Motor Vehicle in Transport
039730	Slowing in Traffic, Changing Lanes	None	Motor Vehicle in Transport
000331	Following Roadway	None	Motor Vehicle in Transport, Guardrail Face
026064	Following Roadway	None	Went Off Roadway Right

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
010001	Apparently Normal	Ran off Roadway	3
084091	Apparently Normal, Other	Failed to Yield Right-of-Way, No Contributing Action	5,5,5
080822	Apparently Normal	Drove Too Fast For Conditions, No Contributing Action	3,5,4,5
012723	Apparently Normal	No Contributing Action	5,5,5,5
014659	Asleep or Fatigued	Failed to Keep in Proper Lane	5
083607	Apparently Normal	No Contributing Action	3
041156	Apparently Normal, Physically Impaired or Handicapped	No Contributing Action, Other Contributing Action	4,5,5,5,5
109346	Apparently Normal	No Contributing Action, Followed Too Closely	3,3,4
109371	Apparently Normal	Followed too Closely, No Contributing Action	5,5
067724	Apparently Normal	Ran off Roadway, No Contributing Action	4,5
031268	Apparently Normal	Drove Too Fast For Conditions	4
047349	Apparently Normal	Followed too Closely, No Contributing Action	5,5,4
000121	Apparently Normal	No Contributing Action	5,5,5,5
033699	Apparently Normal	Ran off Roadway	5
002573	Apparently Normal	Drove too Fast For Conditions, No Contributing Action	4,5
080822	Apparently Normal	Followed too Closely, No Contributing Action	4,5,4,5,5,5,5,5,5
047288	Apparently Normal	Followed too Closely, No Contributing Action	5,5,5,5,5,4,5
051122	Asleep or Fatigued	No Contributing Action	5
008464	Apparently Normal	Ran off Roadway	5
085178	Apparently Normal	Failed to Keep in Proper Lane, Operated Motor Vehicle in Erratic, Reckless, Careless, Negligent or Aggressive Manner	5,5,5
032574	Apparently Normal	Followed too Closely, No Contributing Action	5,5
020684	Apparently Normal	Drove Too Fast For Conditions	5
065907	Apparently Normal	No Contributing Action, Other Contributing Action, Followed too Closely	5,5,5,5,5,5,4
043923	Apparently Normal	Followed too Closely, No Contributing Action	5,5,5,5,5,5
039730	Apparently Normal	Followed too Closely, No Contributing Action	5,5,5,5
000331	Apparently Normal	Drove Too Fast For Conditions	5
026064	Apparently Normal	Drove Too Fast For Conditions	5

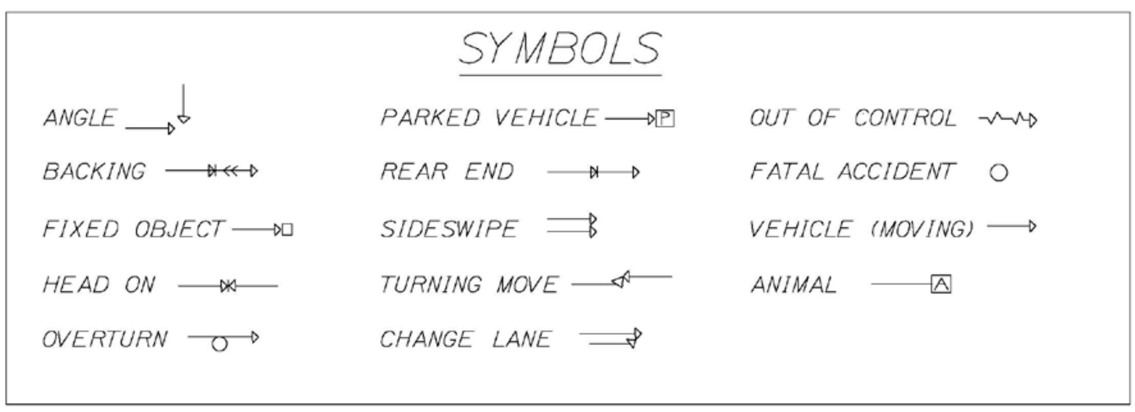
SEGMENT LENGTH: .13 MILES
NUMBER OF CRASHES: 8
CRASH RATE FACTOR: 1.43

ELEMENT: 239715
MILE MARKER: EXIT 32
LOCATION: EXIT 32 (BIDDEFORD) ON RAMP

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 239715



NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
3707	2/4/2012	Sat	12:00	Other	Rear End/Sideswipe		
3302	2/6/2012	Mon	11:25	Straight Road	Rear End/Sideswipe	Guardrail	
40335	10/1/2012	Mon	7:55	Other	Rear End/Sideswipe		
42180	10/24/2012	Wed	12:30	Other	Rear End/Sideswipe		
47293	12/14/2012	Fri	14:55	Other	Rear End/Sideswipe		
24791	8/23/2013	Fri	16:12	Other	Rear End/Sideswipe		
6670	2/24/2014	Mon	16:27	Other	Rear End/Sideswipe		
32732	11/22/2014	Sat	18:20	Other	Rear End/Sideswipe		

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
3707	Other	Daylight	Clear	Dry	Level	No	10
3302	None	Daylight	Clear	Dry	Level	No	35
40335	None	Daylight	Cloudy	Wet	Level	No	10
42180	Other	Daylight	Clear	Dry	Level	No	10
47293	Other	Daylight	Clear	Dry	Level	No	10
24791	Other	Daylight	Clear	Dry	Level	No	10
6670	Traffic Signals (Flashing)	Daylight	Clear	Dry	Level	No	10
32732	Traffic Signals (Stop & Go)	Dark-Lighted	Clear	Dry	Level	No	10

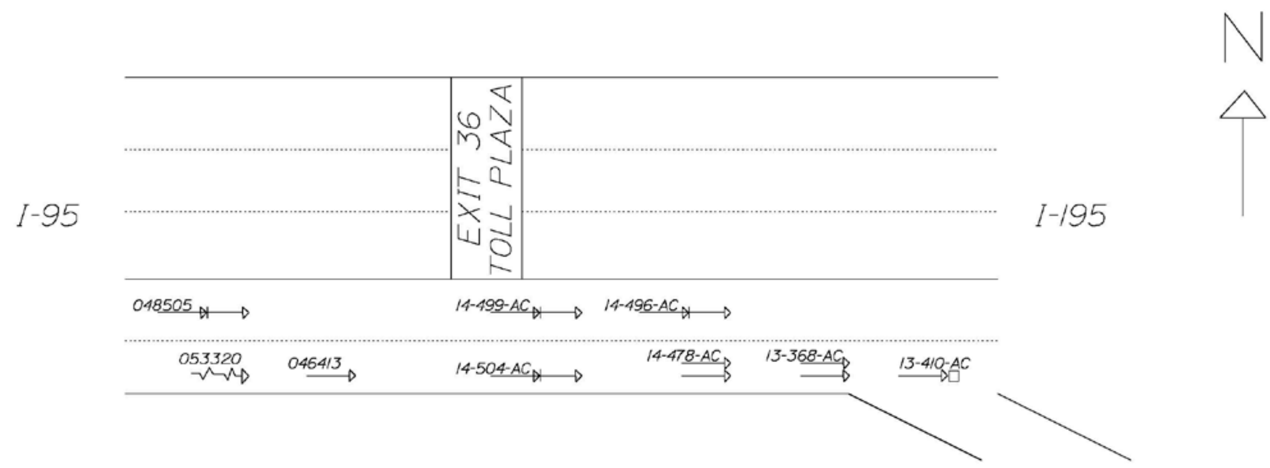
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
3707	Making Right Turn, Following Roadway	None	Motor Vehicle in Transport
3302	Changing Lanes	None	Motor Vehicle in Transport
40335	Slowing in Traffic, Avoiding Vehicle Object, Pedestrian, Animal in Roadway	None	Motor Vehicle in Transport
42180	Stopped in Traffic, Slowing in Traffic	None	Motor Vehicle in Transport
47293	Changing Lanes, Following Roadway	None	Motor Vehicle in Transport
24791	Merging, Stopped in Traffic	None	Motor Vehicle in Transport
6670	Stopped in Traffic, Backing	None	Motor Vehicle in Transport
32732	Backing, Parked Legally	None	Motor Vehicle in Transport

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
3707	Apparently Normal	Improper Turn, No Contributing Action	5,5
3302	Apparently Normal	Other Contributing Action	5,5
40335	Apparently Normal	Followed Too Closely, No Contributing Action	4,5
42180	Apparently Normal	Followed Too Closely, No Contributing Action	4,4,4,4,5
47293	Apparently Normal	Failure to Keep in Proper Lane, No Contributing Action	5,5
24791	Apparently Normal	Followed Too Closely, No Contributing Action	5,5,5
6670	Apparently Normal	Improper Backing, No Contributing Action	5,5
32732	Apparently Normal	Improper Backing, No Contributing Action	5,5

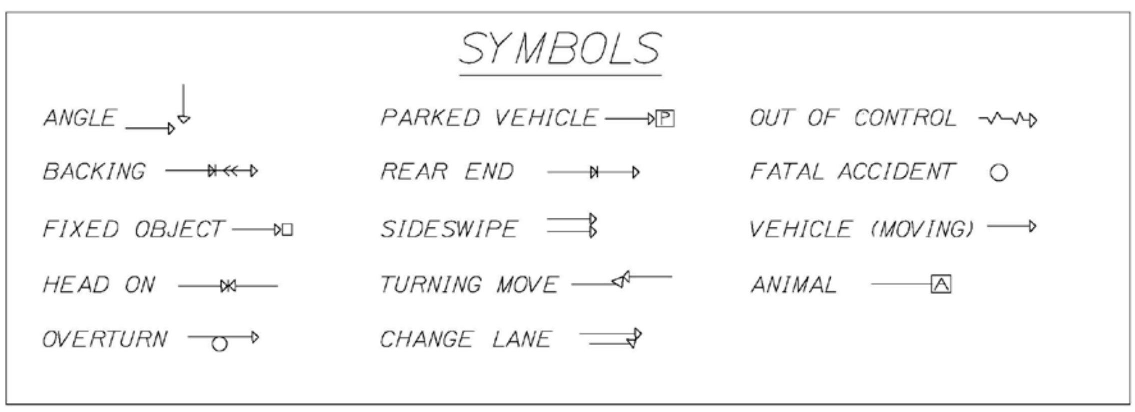
SEGMENT LENGTH: .18 MILES
NUMBER OF CRASHES: 9
CRASH RATE FACTOR: 1.57

ELEMENT: 3114457
MILE MARKER: EXIT 36
LOCATION: EXIT 36 TOLL PLAZA TO I-195 EXIT 1

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



ELEMENT 3114457



NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
053320	8/5/2012	Sun	19:00	Straight Road	Other		
048505	6/9/2014	Mon	17:25	Interchanges	Rear End/Sideswipe		
046413	6/26/2013	Wed	13:05	Straight Road	Fire		
14-478-AC	11/3/2014	Mon	17:22	Interchanges	Rear End/Sideswipe		
14-496-AC	11/17/2014	Mon	17:38	Interchanges	Rear End/Sideswipe		
14-504-AC	11/21/2014	Fri	17:21	Interchanges	Rear End/Sideswipe		
14-499-AC	11/18/2014	Tue	17:17	Straight Road	Rear End/Sideswipe		
13-368-AC	8/15/2013	Thu	17:27	Interchanges	Intersection Movement		
13-410-AC	9/14/2013	Sat	17:56	Interchanges	Went Off Roadway	Guardrail	

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
053320	None	Dusk	Rain	Wet	Level	No	35
048505	None	Daylight	Cloudy	Dry	Level	No	35
046413	Other	Daylight	Cloudy	Dry	Level	No	35
14-478-AC	Advisory/Warning Sign	Dark-Lighted	Clear	Dry	Level	No	35
14-496-AC	Advisory/Warning Sign	Dark-Not Lighted	Rain	Wet	Level	No	35
14-504-AC	Advisory/Warning Sign	Dark-Not Lighted	Clear	Dry	Level	No	35
14-499-AC	None	Dark-Lighted	Clear	Dry	Level	No	60
13-368-AC	None	Daylight	Clear	Dry	Level	No	55
13-410-AC	None	Daylight	Cloudy	Dry	Level	No	55

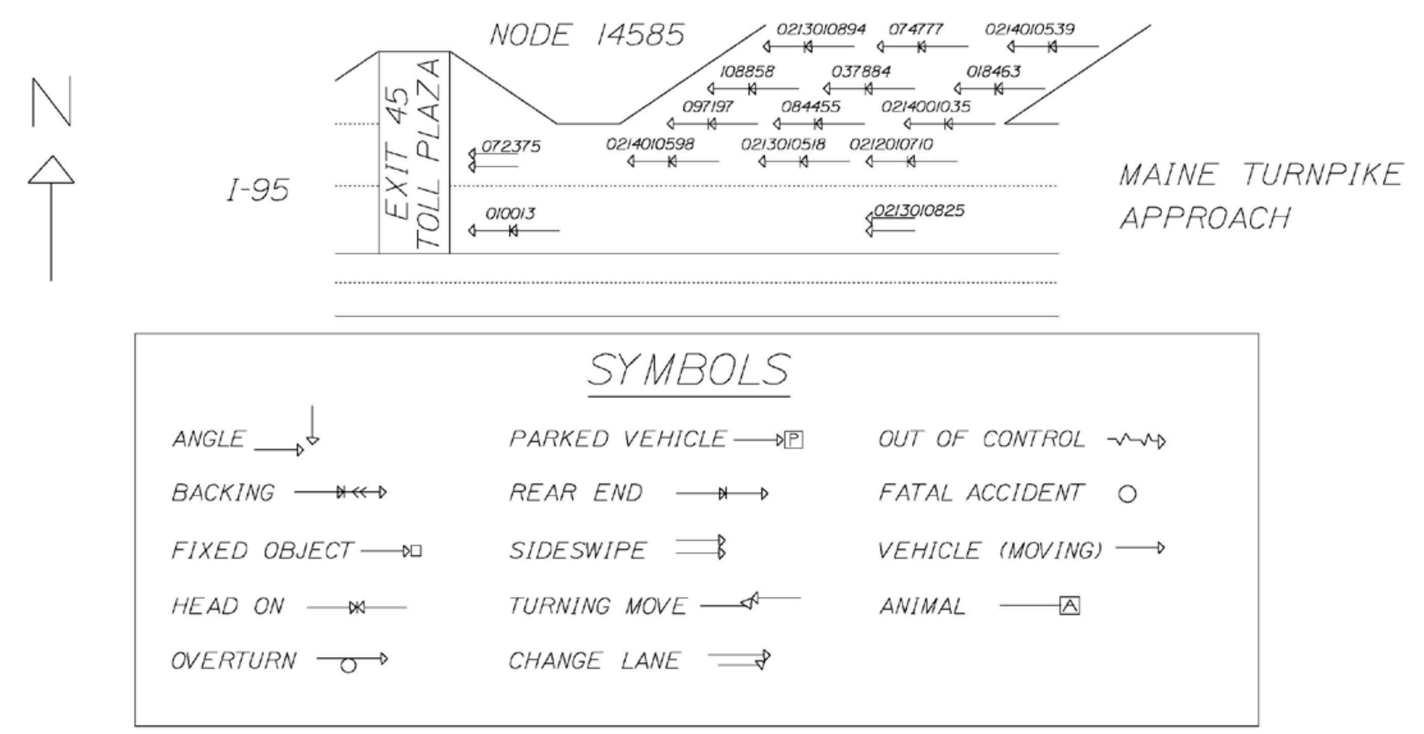
NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
053320	Avoiding Vehicle Object, Pedestrian, Animal in Roadway	None	Other Non-Collision
048505	Changing Lanes, Slowing Traffic	None	Motor Vehicle In Transport
046413	Following Roadway	Other	Motor Vehicle In Transport
14-478-AC	Changing Lanes, Following Roadway	None	Motor Vehicle In Transport
14-496-AC	Slowing in Traffic, Following Roadway	None	Motor Vehicle In Transport
14-504-AC	Following Roadway, Slowing in Traffic, Stopped in Traffic	None	Motor Vehicle In Transport, No Other Events
14-499-AC	Following Roadway, Slowing in Traffic, Stopped in Traffic	None	Motor Vehicle In Transport
13-368-AC	Changing Lanes, Following Roadway	None	Motor Vehicle in Transport
13-410-AC	Following Roadway	None	Motor Vehicle in Transport

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
053320	Apparently Normal	Followed Too Closely	3
048505	Apparently Normal	Followed Too Closely, No Contributing Action	5,5,5
046413	Apparently Normal	No Contributing Action	5
14-478-AC	Apparently Normal	Failed to Keep in Proper Lane, No Contributing Action	5,5
14-496-AC	Apparently Normal	Followed Too Closely, No Contributing Action	5,5,4
14-504-AC	Apparently Normal	Followed Too Closely, No Contributing Action	5,5,5
14-499-AC	Apparently Normal	Followed Too Closely, No Contributing Action	5,5,5,5
13-368-AC	Apparently Normal	Failed to Keep in Proper Lane, Failed to Yield Right-of-Way, No Contributing Action	5,5
13-410-AC	Ill (Sick)	Ran Off Roadway	4

SEGMENT LENGTH: N/A
NUMBER OF CRASHES: 12
CRASH RATE FACTOR: 3.29

NODE: 14585
MILE MARKER: N/A
LOCATION: INT OF MAINE TURNPIKE ON RAMP C0420

YEARS REVIEWED: 2012 - 2014
DATE PREPARED: 10/26/2015
PREPARED FOR: MTA



NUMBER	DATE	DAY OF WEEK	TIME OF DAY	LOCATION	TYPE	FIXED OBJECT STRUCK	OTHER PROPERTY DAMAGE
10013	2/14/2012	Tue	7:20	Interchanges	Rear End/Sideswipe		
212010710	9/28/2012	Fri	17:23	Interchanges	Rear End/Sideswipe		
84455	12/14/2012	Fri	17:36	Interchanges	Rear End/Sideswipe		
37884	5/22/2013	Wed	17:04	Interchanges	Rear End/Sideswipe		
213010518	7/1/2013	Mon	17:24	Interchanges	Rear End/Sideswipe		
74777	10/8/2013	Tue	17:45	Interchanges	Rear End/Sideswipe		
213010825	10/9/2013	Wed	9:11	Interchanges	Intersection Movement		
213010894	11/4/2013	Mon	10:20	Interchanges	Rear End/Sideswipe		
214001035	1/6/2014	Mon	17:23	Curved Road	Rear End/Sideswipe		
18463	3/5/2014	Wed	17:05	Interchanges	Rear End/Sideswipe		
214010539	6/24/2014	Tue	17:35	Interchanges	Rear End/Sideswipe		
214010598	7/17/2014	Thu	18:42	Curved Road	Rear End/Sideswipe		
72375	8/14/2014	Thu	17:15	Straight Road	Rear End/Sideswipe		
97197	10/30/2014	Thu	16:00	Interchanges	Rear End/Sideswipe		
108858	12/5/2014	Fri	21:25	Interchanges	Rear End/Sideswipe		

NUMBER	TRAFFIC CONTROL DEVICE	LIGHT	WEATHER	ROAD SURFACE	ROAD CHARACTER	ROAD WORK	SPEED LIMIT
10013	Advisory/Warning Sign	Daylight	Clear	Dry	Level	No	35
212010710	None	Dusk	Rain	Wet	Level	No	25
84455	Yield Sign	Dark-Lighted	Clear	Dry	Level	No	35
37884	Yield Sign	Daylight	Cloudy	Dry	Level	No	35
213010518	Yield Sign	Daylight	Cloudy	Wet	Level	Yes	35
74777	Yield Sign	Daylight	Clear	Dry	Level	No	25
213010825	Yield Sign	Daylight	Clear	Dry	Level	No	35
213010894	Yield Sign	Daylight	Clear	Dry	Level	No	30
214001035	Yield Sign	Dark-Not Lighted	Rain	Wet	Level	No	25
18463	Yield Sign	Daylight	Clear	Dry	Level	No	35
214010539	None	Daylight	Clear	Dry	Level	No	30
214010598	Yield Sign	Daylight	Clear	Dry	Level	No	25
72375	None	Daylight	Clear	Dry	Level	No	25
97197	Yield Sign	Daylight	Clear	Dry	Level	No	10
108858	Yield Sign	Dark-Lighted	Snow	Dry	Level	No	35

NUMBER	PRE CRASH ACTIONS	CONTRIBUTING CIRCUMSTANCES - VEHICLE	SEQUENCE OF EVENTS 1
10013	Following Roadway, Stopped in Traffic	None	Motor Vehicle In Transport
212010710	Merging	None, Wipers	Motor Vehicle In Transport
84455	Merging, Following Roadway	None	Motor Vehicle In Transport
37884	Merging, Stopped in Traffic	None	Motor Vehicle In Transport
213010518	Making Right Turn	None	Motor Vehicle In Transport
74777	Merging, Stopped in Traffic	None	Motor Vehicle In Transport
213010825	Merging, Following Roadway	None	Motor Vehicle In Transport
213010894	Stopped in Traffic, Following Roadway	None	Motor Vehicle In Transport
214001035	Following Roadway	None	Motor Vehicle In Transport
18463	Merging, Stopped in Traffic	None	Motor Vehicle In Transport
214010539	Merging, Following Roadway	None	Motor Vehicle In Transport
214010598	Slowing in Traffic, Following Roadway	None	Motor Vehicle In Transport
72375	Making Left Turn, Following Roadway	None	Motor Vehicle In Transport
97197	Slowing in Traffic, Stopped in Traffic	None	Motor Vehicle In Transport
108858	Stopped in Traffic, Following Roadway	None	Motor Vehicle In Transport

NUMBER	CONDITION AT TIME OF CRASH	DRIVER ACTIONS AT TIME OF CRASH	INJURY DEGREE
10013	Asleep or Fatigued, Apparently Normal	Followed Too Closely, No Contributing Action	5,5
212010710	Apparently Normal	No Contributing Action	5,5
84455	Apparently Normal	Other Contributing Action, No Contributing Action	5,5,5
37884	Apparently Normal	Followed Too Closely, No Contributing Action	5,5
213010518	Apparently Normal	Followed Too Closely, No Contributing Action	5,5
74777	Apparently Normal	Failed to Yield Right-of-Way, No Contributing Action	5,5,5,5
213010825	Apparently Normal	Failed to Yield Right-of-Way, No Contributing Action	5,4
213010894	Apparently Normal	Followed Too Closely, Other Contributing Action, No Contributing Action	4,5
214001035	Apparently Normal	Followed Too Closely, No Contributing Action	5,5
18463	Apparently Normal	Followed Too Closely, No Contributing Action	5,5
214010539	Apparently Normal	Followed Too Closely, No Contributing Action	5,5
214010598	Apparently Normal	Followed Too Closely, No Contributing Action	5,5
72375	Apparently Normal	Failed to Keep in Proper Lane, No Contributing Action	5,5
97197	Apparently Normal	Followed Too Closely, No Contributing Action	5,4
108858	Apparently Normal	Followed Too Closely, No Contributing Action	5,5,5

Appendix E Peak Hour Growth Rate Forecasts

The following memorandum was submitted in August 2015 for Authority approval. It documents the methodology used to determine the assumed rate of peak-hour traffic growth.

HNTB

Date
August 21, 2015

To
Doug Davidson

Interoffice Correspondence

From
HNTB

Subject
Proposed Peak Hour Traffic Growth Rate for the Safety and Capacity Study

E-1. Background

HNTB is performing a focused traffic operation and safety study of the Maine Turnpike (Turnpike). HNTB previously prepared a systemwide Safety and Capacity Study in 2012. At that time, traffic trends were such that overall traffic on the Turnpike was less than levels of 2005. However, traffic has recently begun to increase at a greater rate which will affect the timeline of improvements outlined in the previous Safety and Capacity Study. This 2015 study includes an assessment of both current and future operating conditions of all interchanges, mainline sections, and ramps on the Turnpike between Kittery and Exit 53. This study also includes an assessment of safety for all mainline sections, ramps, and toll plazas.

E-2. Introduction

An important factor for the basis of the Safety and Capacity Study is the growth rate in peak hour traffic. The growth rate has a direct impact on the timeline for when capacity improvements are needed – the larger the growth rate, the sooner improvements are needed.

To develop a peak hour traffic growth rate, two sources of data were considered – historic peak hour growth rates and annual traffic growth rates developed as part of the Maine Turnpike Authority's Revenue Certificate. One method to predict future traffic growth is to look at historic traffic growth and apply the historic growth rate to current peak hour traffic to develop future traffic volumes. Also, the Maine Turnpike regularly estimates annual traffic growth as part of the Revenue Certificate. It should be noted that the growth rate for the Revenue Certificate is for **annual** traffic, and traffic during the **peak hour** is what drives the need for capacity improvements and is therefore being analyzed in the Safety and Capacity Study.

E-3. Historic Peak Hour Traffic Growth

HNTB gathered hourly data on entering traffic from all toll plazas with the Safety and Capacity study area – from York to Exit 53 for 2005 and 2014-2015 (which includes data from July 2015). The following table is a summary of the peak hours at the toll plazas for those years. Data in the table is summarized by different regions of the Turnpike which have characteristics that could cause different growth patterns. Those regions are – south of York, York to Biddeford, Biddeford to Scarborough, Scarborough to Falmouth.

Table 1 – Maine Turnpike Peak Hour Traffic Summary (Exits 7-53)

Toll Plaza	Direction	30th High Hour Traffic Volumes			*Regions of the Turnpike*	*2005 Sub-Totals*	*2014 Sub-Totals*	*% Annual Change*
		2005	*2014*	*Annual % Change*				
7	NB	3,612	3,810	0.6%				
7	SB	3,661	3,811	0.4%				
19	NB	474	518	1.0%	MM 0-7	7,273	7,621	0.5%
25	NB	518	568	1.0%				
25	SB	216	262	2.2%				
32	NB & SB	1,428	1,655	1.7%				
36	NB & SB	1,956	2,157	1.1%	MM 7-32	2,636	3,003	1.5%
42	NB & SB	588	788	3.3%				
44	SB	1,305	1,685	2.9%	MM 32-42	3,972	4,600	1.6%
45	NB & SB	1,504	1,566	0.4%				
46	NB	890	942	0.6%				
46	SB	486	564	1.7%				
47	NB & SB	555	613	1.1%				
48	SB	1,048	965	-0.9%				
52	Entering	1,003	881	-1.4%				
53	NB & SB	859	925	0.8%				
					MM 42-53*	6,187	7,083	1.5%

*Does not include Exits 48 and 52 which were affected by construction

As can be seen from the preceding table, Exits 48 and 52 show negative growth. However, Exits 48 and 52 were also under construction during 2014 which most likely had an impact on the traffic at those interchanges.

Peak hour traffic growth at York is affected by the constraint of the Piscataqua River Bridge. It is not uncommon to see traffic congestion on the bridge during peak times. The traffic bottleneck on the bridge in the northbound direction prevents the total traffic demand from reaching the York Toll Plaza. The traffic bottleneck on the bridge southbound can cause traffic queues to reach the York Toll Plaza, thus creating a restriction on the number of cars that can pass through the toll plaza during an hour. Therefore, the actual peak hour traffic **counts** at York Toll Plaza may not accurately reflect the traffic demand due to the bridge.

The average annual growth for the different regions of this southerly section of the Turnpike is between 0.5-1.6%, with the regions south of York seeing the lowest growth and the Biddeford to Scarborough regions seeing the highest growth.

E-4. Other Traffic Forecasts

Annual traffic forecasts were prepared by HNTB for the Toll Revenue Certificate and by CDM Smith for the anticipated issuance of toll revenue bonds. As mentioned earlier, these traffic forecasts were developed for **annual** traffic numbers. Growth in annual traffic does not necessarily correspond to growth in the peak hour traffic. But, the two growth rates could be expected to be consistent. The annual traffic growth rates developed for the Toll Revenue Certificate and the issuance of toll revenue bonds are as follows.

- The average five-year growth rate from the 2015 Toll Revenue Certificate is 1.2 %.
- The average five-year growth rate from the 2015 CDM Smith letter is 1.7%
- The average ten-year growth rate from the 2015 CDM Smith letter is 1.4%
- The average twenty-year growth rate from the 2015 CDM Smith letter is 1.2%

As can be seen, the annual traffic growth rates estimated from the Toll Revenue Certificate and the issuance of toll revenue bonds are consistent with the historic peak hour traffic growth.

E-5. Conclusions

Based on the preceding information, HNTB recommends the following growth rates for use in the 2015 Safety and Capacity Study

- 0.5% for the region of the Turnpike south of the York Toll Plaza due to the constraint of the Piscataqua River Bridge
- 1.6% for the region of the Turnpike from Exit 32-Exit 42 in the area of Biddeford, Saco, and Scarborough.
- 1.5% for the regions York-Biddeford and Scarborough-Falmouth.

Appendix F. Additional VISSIM Traffic Analysis for the Exit 36 Southbound Off-Ramp

As described in Section 5 of the Safety and Capacity Report, the traffic conditions of the Exit 36 southbound off-ramp was studied in more detail than the planning level analysis for the remainder of the Turnpike. The reason for this additional analysis was to understand the traffic congestion that is experienced on the Turnpike in the southbound direction north of the Exit 36 southbound off-ramp and to evaluate the relative effectiveness of three different build alternatives to address this traffic congestion.

The study area for this analysis was extended easterly to the intersection of Industrial Park Road and the off-ramp from I-195 eastbound. Traffic regularly backs up on the ramp to Industrial Park Road from I-195 eastbound. These queues spill onto I-195 eastbound towards the Turnpike southbound. This analysis takes a holistic look at traffic conditions downstream of the Exit 36 off-ramp to gauge the impact on the off-ramp and the Turnpike southbound north of Exit 36.

F.1 Methodology

Traffic operations were analyzed with VISSIM. VISSIM is a microscopic, time step and behavior-based traffic simulation model (see Section 4 for a more detailed description). The VISSIM model described in Section 5 that represents a summer weekday afternoon was used for this additional analysis as that time period represents when traffic is heaviest on the Exit 36 southbound off-ramp and on the adjacent section of the Turnpike.

In addition, turning movement counts were obtained from the MaineDOT for the intersection of Industrial Park Road and the I-195 eastbound off-ramp. The turning movement counts were adjusted and balanced to correspond with the Turnpike peak and added to the summer weekday afternoon model.

Queues were measured at the diverge of the Exit 36 off-ramps. In a well-functioning ramp, no queues would develop. Therefore, the presence of a traffic queue would indicate that the diverging vehicles are experiencing traffic congestion which is an unsafe condition on the Turnpike. Density measurements for the merge and diverge areas of all of the ramps (outputs from the model) were used to determine the corresponding level of service.

F.2 Site Visit

HNTB visited the Exit 36 study area (shown in Figure 1) on two sunny Wednesdays – one in February and one in March. During the visits we drove along the Turnpike southbound to Exit 36 and then parked at the park and ride lot next to the intersection of Industrial Park Road and the I-195 off-ramp in order to observe afternoon peak hour traffic. The time of observations was between 4:45 – 5:45 p.m. The following was observed and are shown graphically in Figure 1.

1. Travel speeds on the Turnpike southbound right lane ranged from 65-70 mph[4]
2. There was a momentary stoppage on the Exit 36 southbound ramp due to traffic congestion.
3. Queues from the intersection of Industrial Park Road and I-195 eastbound off-ramp extended back onto I-195 eastbound and were observed to extend to the toll plaza.
4. Approximately 27 left-turning vehicles from the I-195 eastbound off-ramp were able to clear during each green phase of the traffic signal cycle.

Figure F.2-1 – Exit 36 Southbound Afternoon Peak Hour Traffic Issues

F.3 2014 and 2015 Traffic Analysis

HNTB used the site visit information gathered to calibrate the model. The site visit was during a lower traffic time period – winter. Whereas, the VISSIM traffic model used for this analysis reflects a summer condition. Observations that were used to calibrate the model are traffic behaviors that would exist in either condition such as number of vehicles clearing a green traffic signal phase when conditions are congested, where traffic slows down, and where queues form.

[4] This is consistent with speeds measured by radar during the month of September 2013 where the 85th percentile speed for the southbound right lane was found to be 71.6 mph. But the 85th percentile speed for weekday afternoons between 4:00 – 6:00 p.m. was lower – 69.3 mph.

The baseline summer weekday afternoon peak hour traffic volumes for 2014 (consistent with the Safety and Capacity Study) were input into the VISSIM model and analyzed. In addition, traffic for 2015 (2014 traffic increased by 1.6% consistent with the Safety and Capacity Study) was also input into the VISSIM model and analyzed. The LOS and 95th percentile queues for the Exit 36 interchange is illustrated in Table F.3-1.

Table F.3-1 – 2014 and 2015 LOS & Queue Summary for the Saco Interchange

	2014 PM		**2015 PM**	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
36 NB off	A	--	A	--
36 NB on	B	NO	B	NO
36 SB off	C	NO	D	YES - 744
36 SB on	B	NO	B	NO

As can be seen from the table above, all merge and diverge areas are shown to operate at an acceptable LOS during 2014. However, in 2015, the model shows queues developing on the Turnpike. The queues developed from the ramp to Industrial Park Road. Queues build up on the ramp due to the heavy left turn traffic volume coming off the ramp – 772 vehicles in the peak hour. These queues spill onto I-195 eastbound. Occasionally, during the peak hour the queues can spill onto the Turnpike southbound. These queues are longer than what was observed during field visits made in February and March. But traffic in the summer is about 15-20% higher in the summer than in February and March.

F.4 2034 No-Build Traffic Analysis

The 2014 balanced peak hour traffic volumes were increased at a rate of 1.6% per year to the design year of 2034. The estimated 2034 peak hour traffic volumes were input into the detailed VISSIM model and analyzed. The LOS and 95th percentile queues for the Saco interchange is illustrated in Table F.4-1.

Table F.4-1 – 2034 LOS and Queue Summary for the Saco Interchange

	PM	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)
36 NB off	B	--
36 NB on	B	NO
36 SB off	F	YES – 1670*
36 SB on	B	NO

*Queues only measured to approximately 1,670 feet. Actual queue could be larger.

As can be seen from the table above, the Exit 36 southbound off-ramp is expected to operate at LOS F in 2034, as was shown in Section 5. Queuing can be expected to be extensive resulting in very congested and unsafe conditions.

F.5 2034 Traffic Analysis of Alternatives

A Synchro/Simtraffic traffic model was set up with the 2014 traffic volumes at Industrial Park Road to determine if signal timing and phasing improvements could be made to the intersection in order to prevent the queuing onto I-195 eastbound. It was found that with optimized signal timing and phasing the intersection would operate at a LOS E in 2014. This indicates that the intersection is at capacity. Any traffic volume increases would put the intersection over capacity. Signal timing improvements alone would not be able to accommodate all of the traffic demand at the intersection. Traffic at the intersection already has long queues in all directions. Giving more green time to the off-ramp would result in longer queues on Industrial Park Road, which could spill back to the intersection with Route 112. Because of this, an alternative with signal timing improvements only was not evaluated further.

Three improvements alternatives were identified based on the results of the 2014 and 2034 No-Build traffic analysis. They are described below and shown in Figure 2.

Alternative 1 – Widen the Exit 36 southbound ramp to two lanes. Expansion area is shown in orange on Figure 2.

Alternative 2 – Widen Industrial Park Road to two thru lanes in the southbound direction immediately south of the I-195 eastbound off-ramp and add an additional 250 foot left-turn auxiliary lane on the I-195 eastbound off-ramp. Expansion area is shown in green on Figure 2.

Alternative 3 – All of the improvements from Alternatives 1 and 2.

Figure F.5-1 – Exit 36 Traffic Improvement Areas

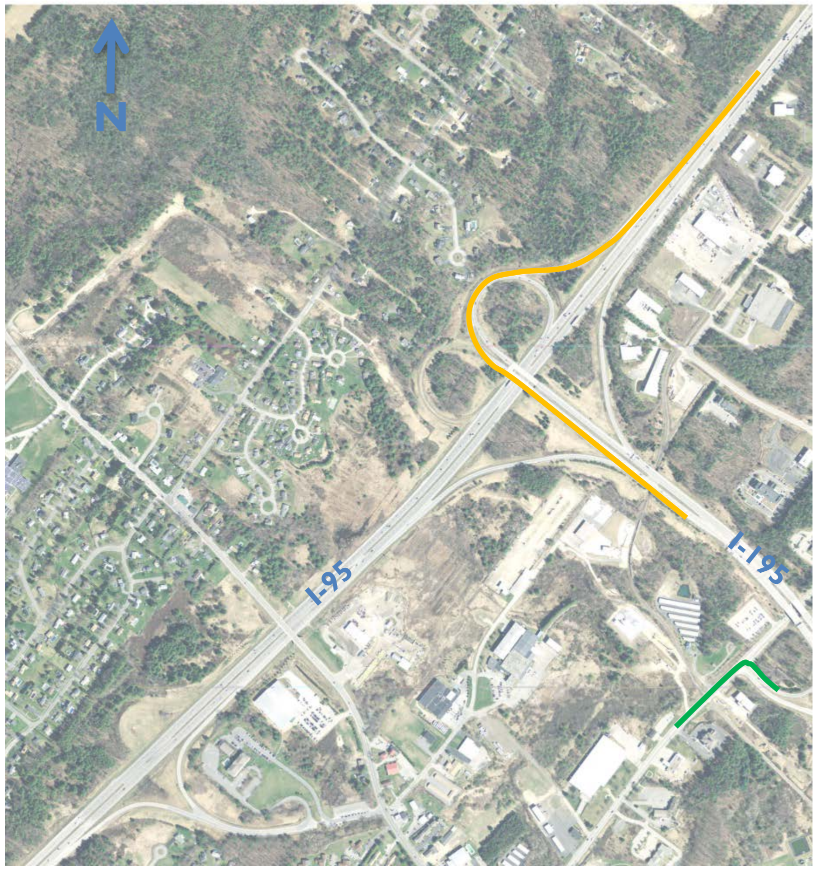


Table F.5-1 shows the LOS and queue results for the three alternatives.

Table F.5-1 – 2034 PM LOS and Queue Summary for the Saco Interchange

	Alternative 1		Alternative 2		Alternative 3	
Analysis Area	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)	LOS	Significant Queues Develop? (>200 ft.)
36 NB off	F	YES – 1670*	B	NO	B	NO
36 NB on	B	NO	B	NO	B	NO
36 SB off	F	YES – 1670*	F	YES – 891	B	NO
36 SB on	B	NO	B	NO	B	NO

*Queues only measured to approximately 1,670 feet. Actual queue could be larger.

As can be seen from Table F.5-1, Alternative 1 will not solve the traffic issues at the Exit 36 southbound off-ramp. In fact it would actually degrade operations at the Exit 36 northbound off-ramp. In order to accommodate an extra lane on the Exit 36 southbound off-ramp, the northbound off-ramp loses its lane on I-195 eastbound. Instead of freely coming into its own lane, it must merge with the traffic from the Exit 36 southbound off-ramp. In Alternative 1, the southbound off-ramp remains congested, so the northbound ramp becomes congested as it has to merge with the southbound traffic.

Making improvements to Industrial Park Road and the I-195 off-ramp to Industrial Park Road improves traffic conditions in the study area as shown in the results for Alternative 2. But these improvements are still not enough to improve the level of service for the Exit 36 southbound off-ramp traffic, which would still function at a LOS F and experience significant queuing.

With Alternative 3, all diverge and merge areas at Exit 36 function at a level of service B with no queuing issues. The northbound off-ramp improves over Alternative 1 because the southbound off-ramp is no longer congested.

F.6 Conclusions

This detailed analysis shows that traffic congestion on the Maine Turnpike in the southbound direction north of Exit 36 stems from the queues that build up on I-195 eastbound from the intersection of the I-195 eastbound off-ramp and Industrial Park Road. Widening the Exit 36 southbound off-ramp without making improvements to the intersection of the I-195 eastbound off-ramp and Industrial Park Road will not improve Turnpike traffic conditions and will cause problems for the Exit 36 northbound off-ramp traffic. Conversely, improvements to the intersection of the I-195 eastbound off-ramp and Industrial Park Road will improve traffic conditions, but as mentioned in Section 3, the Exit 36 southbound off-ramp will need to be widened by 2032. As mentioned in Section 7, widening the Exit 36 southbound off-ramp would cost approximately $2.0 million[5]

Since, the intersection of the I-195 eastbound off-ramp and Industrial Park Road is not within the Maine Turnpike Authority's jurisdiction, any improvements made to this intersection would have to be coordinated with MaineDOT. The approximate cost of widening Industrial Park Road and the I-195 eastbound off-ramp is $1.5 million. It should be noted that any widening of Industrial Park Road could impact Goosefare Brook, which is an Urban Impaired Stream. As this intersection is already at capacity, improvements are needed in 2016.

Queues developing on the Turnpike are an incredibly unsafe condition and can occur during peak periods. An interim solution could be to build a deceleration lane for the southbound off-ramp traffic to help get queued traffic out of the thru lanes.

[5] 2015 dollars