Appendix C: Traffic Technical Report

EXIT 4A – Traffic and Transportation Technical Report

I-93 Exit 4A Supplemental Draft Environmental Impact Statement

Prepared for:

Town of Derry
Town of Londonderry
New Hampshire Department of Transportation

Prepared by:

Fuss and O'Neill, Inc.

Final Version

October, 2018

NHDOT Project Number: 13065
Federal Project Number: IM 0931(201)
Fuss & O'Neill Project Number 05-0244

Table of Contents

Table of Contents (Continued)

Tables

Figures

Appendices

1.0 Introduction

The Interstate 93 (I-93) Exit 4A Project (the "Project") involves a new diamond interchange between Interstate 93 Exits 4 and 5 in the Town of Londonderry, approximately one mile north of Exit 4. The new diamond interchange would provide access to the east side of I-93 only. A 1-mile connector roadway would be built on new alignment from the interchange to Folsom Road, near the intersection of North High Street and Madden Road, in the Town of Derry. Folsom Road, and subsequently Tsienneto Road, would be upgraded, and the intersections would be improved.

The Project was the subject of a Draft Environmental Impact Statement (DEIS) in 2007 (FHWA, 2007). Due to the amount of time that has elapsed since the 2007 DEIS, the FHWA has requested the preparation of updated studies that will be documented in a Supplemental Draft Environmental Impact Statement (SDEIS) in accordance with the National Environmental Policy Act (NEPA). The SDEIS will provide an up-to-date assessment of the environmental effects of the Project and the evaluation of reasonable alternatives that will consider updated information including, but not limited to, traffic, socioeconomic projections, land development proposals in the project area, and changes in environmental resources and regulatory requirements.

The purpose of this report is to document the development of traffic projections and operational analyses for the Project as part of the SDEIS. This report is a compilation of previous memoranda issued as the project proceeded as well as to present the findings of the analyses of the various alternatives.

The traffic analysis tasks described in this report includes the following:

- Collection of traffic count data at various roadways and intersections in the Exit 4A study area to develop 2015 Average Weekday Traffic (AWDT) volumes.
- Use of these 2015 counts to calibrate the Southern New Hampshire Planning Commission (SNHPC)'s regional traffic model to be viable to project future traffic volumes in the 2040 design year with and without the proposed Exit 4A.
- Preparation of land use and socioeconomic projections (conducted concurrently by the Land Use Working Group) for the SNHPC model area and allocated to the Traffic Analysis Zone (TAZ) level for each alternative scenario to be used as the basis for traffic generation and trip assignments to the regional roadway network.
- Development of 2040 No-Build (without Exit 4A) and Build (with Exit 4A) traffic volume assignments on key roadway segments and intersections in the study area network.
- Derivation of AM and PM peak hour traffic volumes on the mainline I-93 and interchange ramps as well as key segments and intersections in the study area for the various Exit 4A alternative layouts for analysis purposes (see Figure 1).
- Analysis of interstate operations using the *2010 Highway Capacity Manual* (TRB, 2010) Freeway Facilities methodologies for the existing 2015 and all 2040 No-Build and Build scenarios. Analysis of signalized and unsignalized intersection operations of the existing 2015 and all 2040 scenarios using HCM methodologies and emulated in the *SYNCHRO/Sim-Traffic (Trafficware, 2016)*software for

derivation of Level of Service and estimated queue lengths for conceptual design purposes.

In addition to the traffic data collection, Project Team specialists and the Land Use Working Group conducted interviews and compiled socioeconomic (e.g., population and employment) projections that were used by the SNHPC to allocate these trip-generation characteristics to their traffic zone system to generate traffic assignments to the roadway network under both No-Build (without 4A) and the Build alternatives that were included in the DEIS from 2007. A separate Land Use Scenario Technical Report was prepared that documents the land use and socioeconomic forecasting efforts that were used in conjunction with the traffic modeling. (Louis Berger, 2017).

2.0 Purpose and Need for the Project

The Purpose and Need for the Project, as described in the 2007 DEIS, is as follows:

- Providing for transportation improvements that will promote the safe and efficient movement of people, goods, and services between I-93 and the towns served by NH Route 102, specifically Derry and Londonderry, that are immediately adjacent to I-93 Exit 4;
- Providing an alternative route to the Interstate system for traffic using NH Route 102 to and from the east, thus removing a large volume of through traffic from the heavily congested downtown Derry street network;
- Providing improved Interstate access for commercially and industrially zoned lands near NH Routes 28 and 102 in both Derry and Londonderry, thus allowing for the planned and orderly development of such lands to further locally-defined economic development goals and tax base diversification; and
- Enhancing and promoting the economic vitality of the downtown Derry area, presently characterized by traffic congestion and decreasing vehicular and pedestrian safety, by separating local destination-oriented traffic from through-traffic destined for the Interstate system.

For purposes of this project, the downtown Derry area has been defined as NH Route 102 easterly from its intersection with Fordway to the NH 28 (Crystal Avenue/Birch Street) intersection (CLD|Fuss & O'Neill, 2018). This is also consistent with the defined Central Business District zoning map for the Town of Derry (Town of Derry, 2015).

3.0 Traffic Data Collection

The study area for the Project was established and agreed upon as part of the 2007 DEIS document, and encompasses the expected extent of the roadway network that would likely be influenced by the introduction of a new I-93 interchange and associated connector roadways. An updated inventory of the key area roadways and intersections was conducted to ensure that the traffic modeling and subsequent analyses reflect existing conditions.

The various contracts for the I-93 widening project affecting the study area also needed to be considered. The Exit 5 improvements are already in place, and the Exit 4 interchange is being reconstructed now as part of Contract 14633-D. The widening of the mainline I-93 to four lanes between Exits 4 and 5 under Contracts 'D' and 'I' is also underway.

3.1 Traffic Counts

The traffic counting program was developed for the project, based on the key roadway segments and intersections in the study area, to assist in the development of 2015 base Average Annual Weekday Traffic (AAWDT) volumes for use in the traffic model calibration. Most of these locations were counted in 2005 as part of the preparation of the original 2007 DEIS document. This effort was coordinated with the annual traffic counting programs conducted by both the NHDOT and SNHPC within the study area, and the new data collected in May and June of 2016 while school was still in session. Some of these locations had already been counted in 2014 or 2015 (NHDOT, 2016a, 2016b, 2016c), so all data was evaluated and subsequently adjusted to reflect 2015 AAWDT conditions.

The Automatic Traffic Recorder (ATR) counts were taken for a 3-5 day period. A listing of the locations is included below and shown in Figure 2.

<u>Interstate Locations (15)</u>

I-93 NB and SB, south of Exit 4 (NHDOT permanent recorder)
I-93 Exit 4 – NB and SB on- and off-ramps (5)
I-93 Exit 5 – NB and SB on- and off-ramps (4)
I-93 NB and SB between Exits 4 and 5 (2)
I-93 NB and SB north of Exit 5 (2)

<u>State Highways/Local Streets (22)</u>

Crystal Avenue (NH Route 28), south of Tsienneto Road
Folsom Road, west of NH Route 28
Pinkerton Street, east of Tsienneto Road
Tsienneto Road, east of Pinkerton Street
Chester Road (NH Route 102), east of NH Route 28 Bypass (Sylvestri Circle)
North Main Street (NH Route 28 Bypass), north of Pinkerton Street (Academy Drive)
North Main Street (NH Route 28 Bypass), north of Tsienneto Road
South Main Street (NH Route 28 Bypass), south of Thornton Street
Tsienneto Road, west of NH Route 102
NH Route 102, at Derry Town line
NH Route 28, at Derry/Londonderry Town line
Gilcreast Road, north of NH Route 102
NH Route 102, west of Abbot Street
NH Route 102, east of Griffin Street
Fordway, over Beaver Brook

Franklin Street, north of Folsom Road
Ash Street at Londonderry Town line
Ash Street, east of Londonderry Road
NH Route 28, east of Perkins Road
NH Route 28, south of Rollins Street
NH Route 28, north of Liberty Drive
NH Route 102, east of Hampton Drive

Intersection Turning Movement Counts (TMCs) – AM and PM Peak Periods (19)

The intersection counts were taken in groups of intersections within five general groups or 'zones' in close proximity to each other to facilitate ease of data collection and to minimize significant differences between locations, even if there were intervening roadways or driveways that would not allow balancing between sites. These groups of intersections were numbered as follows and shown in Figure 3:

Zone 1
#3 Exit 5 SB ramps
#4 Exit 5 NB ramps

Zone 2
#1 Exit 4 SB ramps
#2 Exit 4 NB ramps

Zone 3
#5 NH Route 102/Londonderry Road/St. Charles Street
#6 NH Route 102 (Broadway)/Fordway/Madden Hill Road
#7 NH Routes 102/28 (Crystal Avenue/Broadway/Birch Street)
#8 North High Street/Ash Street Extension
#9 North High Street/Madden Road
#10 North High Street/Folsom Road/Franklin Street/Franklin Street Extension

Zone 4
#11 NH Route 28/Folsom Road/Tsienneto Road (Ross' Corner)
#12 Tsienneto Road/Pinkerton Street
#13 NH Route 28/Linlew Drive
#14 NH Route 28/Ashleigh Drive
#15 NH Route 28/Scobie Pond Road

Zone 5
#16 NH Routes 102/28 Bypass/East Derry Road (traffic circle)
#17 NH Route 28 Bypass/Pinkerton Street/Nesmith Street
#18 NH Route 28 Bypass/Tsienneto Road
#19 NH Route 102/Tsienneto Road

Copies of the relevant raw traffic count data are included in Appendix A.

Other new intersections that would be created by some of the Exit 4A alternatives will also need to be evaluated and analyzed. In addition, it was determined as the study progressed that additional intersections at the east end of the study area should be collected, since they will be influenced by any improvements at the NH Route 102/Tsienneto Road intersection. These intersections were at NH Route 102/North Shore Road (#26) and at NH Route 102/English Range Road (#27). This data is also included in Appendix A.

Adjustment Factors used for Data Reduction

Because of the nature of the regional roadway network, there are several different adjustment factors that need to be applied to the raw counts to derive AWDT. In general, there are seasonal factors, annual growth factors, and axle correction factors, based on the type of roadway being considered. NHDOT develops these factors for various roadway types based on their evaluation of permanent traffic recorder stations across the state. NHDOT differentiates between Rural and Urban Interstates (called Groups 1 and 3, respectively), as well as Rural and Urban Highways (Groups 2 and 4, respectively), for which there is a wealth of short-term and long-term factors that are developed annually by NHDOT as part of their normal practice (NHDOT, 2016d). Appendix B includes the tables showing the various seasonal, annual and axle correction factors applied to the raw traffic counts in this report.

Seasonal Factors

In this study area, there are Interstate roadways (I-93) as well as state highways and local streets in an urbanized area, so the Group 3 and 4 seasonal factors in Appendix B were applied here. Since counts were taken on specific dates in May, the 2015 seasonal adjustment factors were applied to each count separately based on the date of the count and the type of roadway.

Annual Growth Factors

Annual growth factors are also applied because of the different years that the counts were taken. There is an NHDOT permanent traffic recorder in the immediate study area on I-93 just south of Exit 4 at the Derry/Windham town line, but it may not be indicative of growth on the local street network because the interstate is more prone to fluctuations in regional traffic. A comparison of May 2015 to May 2016 traffic counts on I-93 indicates a 1.1% growth rate on the Interstate system. It should be noted that this counter is located north of the current construction area, so it should not have been influenced by drivers trying to avoid construction-related delays. This 1.1% annual growth rate was applied to the 2016 mainline I-93 traffic data only to adjust the data downward to the 2015 base year AWDT.

Another permanent recorder is located on NH Route 28 in Windham south of the study area that should be more representative of the urbanized roadways within the Derry/Londonderry area. A comparison of May 2015 to May 2016 traffic counts at the NH Route 28 location indicates a 2.5% growth rate, which was then applied to the rest of the study area roadway system to derive the 2015 AWDT.

There are also ramp volume counts at Exits 4 and 5 that need to be seasonally adjusted**. In discussions with the NHDOT Bureau of Traffic (NHDOT, 2016e), it was agreed that these ramp volumes would exhibit characteristics more in line with the local street network as opposed to seasonal variations in Interstate traffic.** As such, the 2.5% growth rate was also applied to the ramp volumes to derive the 2015 AWDT.

<u>Axle Correction Factors</u>

Axle correction factors are also applied to adjust for differences in vehicle classification on various types of roadways to derive a total number of actual vehicles. It is essentially a correction for the assumed number of two-axle vehicles gathered by the field-counting apparatus (such as road tubes) to account for multi-axle vehicles in the traffic stream, based on the FHWA 13-tiered classification system. These factors are developed by NHDOT based on vehicle classification information collected on the various functional classifications of roadways in the state.

Each of the major roadways in the study area has already been functionally classified based on its overall role in the regional roadway network. Since this is an urbanized area, the classifications that are applied here are urban interstate (FC 11), urban principle arterials (FC 14), urban minor arterials (FC 16), collector roadways (FC 17), and local streets (FC 19). The 2015 axle correction factors table is also provided in Appendix B.

<u>Development of 2015 AAWDT Base Volumes</u>

Table 1 shows a summary of the adjusted 2015 AAWDT volumes derived from applying the various adjustment factors to the 2015 and 2016 raw traffic counts. In some cases, such as for the 2014 counts, the NHDOT has already developed the AAWDT for locations of interest in the study area, which only need to be annually adjusted upward to 2015. This adjustment factor has also been applied to the AM and PM peak hour volumes and ‘k’ factors (the percentage of AAWDT during each peak hour for each movement) calculated for comparison to the intersection TMCs for future analysis purposes.

TABLE 1
ATR Count Summary - Adjusted 2015 AAWDT and Peak Hour Volumes

Annual Growth rates:	
2014->2015	**1.025**
2015->2015	**1.000**
2016->2015	**0.975**

Seasonal: Use Urban Highway Group 4 adjustment factors

Intersection Turning Movement Counts		AM Peak	PM Peak
April	Adj Factor=	**0.96**	**0.99**
May		**0.96**	**0.98**
June		**0.96**	**0.94**
July		**1.04**	**0.96**
Sept		**0.95**	**0.97**

	Count Location	Count Month/Yr	Raw AAWDT	Adj 2015 AAWDT	700-800am Counted AM Peak Volume	Adj 2015 AM Peak Volume	AM Pk as % of AAWDT	400-500pm Counted PM Peak Volume	Adj 2015 PM Peak Volume	PM Pk as % of AAWDT
Derry	Crystal Ave (NH Route 28), S of Tsienneto	May-16	15585	15195	836	803	5.28%	1418	1390	9.15%
	Folsom Rd W of NH Route 28	May-16	12070	11768	778	747	6.35%	1199	1175	9.98%
	Pinkerton St E of Tsienneto	May-16	10722	10454	695	667	6.38%	1017	997	9.54%
	Tsienneto Rd, W of NH Route 102	May-16	5532	5394	483	464	8.60%	511	501	9.29%
	Tsienneto Rd E of Pinkerton	May-16	15012	14637	1113	1068	7.30%	1499	1469	10.04%
	NH Route 102, E of NH Route 28 Bypass	May-16	7456	7270	595	571	7.85%	661	648	8.91%
	NH Route 28 Byp, N of Academy Dr	May-16	8615	8400	756	726	8.64%	881	863	10.27%
	NH Route 28 Byp, N of Tsienneto Rd	May-16	12250	11944	997	957	8.01%	1201	1177	9.85%
	NH Route 28 Byp, S of Thornton Rd	May-16	14341	13982	1110	1066	7.62%	1392	1364	9.76%
	NH Route 102 E of Griffin St	Apr-14	16000	16400	1054	1012	6.17%	1224	1212	7.39%
	NH Route 102 W of Abbot St	Apr-14	14000	14350	1020	979	6.82%	1148	1137	7.92%
	Fordway over Beaver Brook	Apr-14	5200	5330	410	394	7.39%	481	476	8.93%
	Franklin St Ext, N. of Folsom Rd	Apr-14	1800	1845	99	95	5.15%	171	169	9.16%
	Ash St at Londonderry town line	Apr-14	6600	6765	410	394	5.82%	722	715	10.57%
	Crystal Av (NH Route 28), S of Rollins	Jun-15	13000	13000	819	786	6.05%	1174	1104	8.49%
	average						6.90%			9.28%
L-derry	NH Route 102, E of Hampton Dr	Jul-15	32000	32000	2478	2577	8.05%	2842	2728	8.53%
	NH Route 102 at Derry Town line	May-16	22656	22090	1718	1649	7.46%	1796	1760	7.97%
	NH Route 28 at Derry Town line	May-16	17324	16891	1279	1228	7.27%	1682	1648	9.76%
	NH Route 28 N of Liberty Dr	Sep-15	13000	13000	1176	1117	8.59%	1054	1022	7.86%
	Gilcreast Rd N of NH Route 102	May-16	10070	9818	697	669	6.81%	1008	988	10.06%
	Ash St E of Londonderry Rd	Jun-15	6900	6900	427	410	5.94%	723	680	9.86%
	average						7.36%			9.00%
					700-800am			400-500pm		
	Exit 4 NB Off-ramp	May-16	10249	9993	435	418	4.18%	1223	1199	12.00%
	Exit 4 NB On-ramp	May-16	10303	10045	1079	1036	10.31%	812	796	7.92%
	Exit 4 SB Off-ramp	May-16	9862	9615	753	723	7.52%	952	933	9.70%
	Exit 4 SB On-ramp - EB to SB	May-16	5310	5177	673	646	12.48%	311	305	5.89%
	Exit 4 SB On-ramp - WB to SB	May-16	4767	4648	537	516	11.10%	244	239	5.14%
	average						9.12%			8.13%
	Exit 5 NB Off-ramp	May-16	5745	5601	400	384	6.86%	472	463	8.27%
	Exit 5 NB On-ramp	May-16	9580	9341	992	952	10.19%	793	777	8.32%
	Exit 5 SB Off-ramp	May-16	9520	9282	781	750	8.08%	939	920	9.91%
	Exit 5 SB On-ramp	May-16	5645	5504	519	498	9.05%	427	418	7.59%
	average						8.54%			8.52%

Note - Exit 5 SB off-ramp AM peak volume does not include one count that appears anomalous when compared to other counts in same hour

Red counts are from NHDOT Town summary data - 2014-2015

3.2 Existing Signal Information – Timing and Phasing

Information about the current signal timing and phasing plans at each of the signalized intersections was compiled from records available from the entity with current maintenance responsibility, which is either the NHDOT Bureau of Traffic or the Town of Derry (none of the signals in Londonderry are under their jurisdiction). Current records for one of the locations (NH Route 102/Fordway) were not readily available, so the required information was gathered in the field by observation. This information, combined with the current lane use at each location, was compiled into a data file in the SYNCHRO signal analysis program, which emulates the procedures in Volume 3 (Interrupted Flow) of the *Highway Capacity Manual* 2000 *(HCM)* (TRB, 2000) analysis procedures, for use in future analysis. The HCM 2000 procedures are being used for signalized intersections because these procedures can analyze non-standard timing and phasing parameters, since as leading pedestrian start times, which were found in the field, and to be consistent with the analyses in the Interstate Justification Report (Louis Berger, 2018).

3.3 Crash Data – 2010-2014 – Data Reduction and Summary

Data compiled by the NH Department of Safety for the last five full calendar years was made available by the NHDOT for the two study area towns. Since the crash records are identified by State Plane coordinates, this data search was narrowed further to include only those crashes located within the limits of the study area, roughly bounded by I-93 to the west, NH Route 102 to the south, NH Routes 28 and 28 Bypass north of Tsienneto Road to the north, and the Tsienneto Road/NH Route 102 intersection to the east. The records were assigned to specific roadway segments or individual intersections if sufficient locational information was available. In some cases these identifiers overlapped, so the sum of the segment and intersection crashes is more than the total.

The findings are summarized in Table 2 below. A total of 716 crashes were identified within the project area within the five-year time span, with only one fatality (a single-car incident in 2014 on NH Route 102 in Londonderry). About 24% of the crashes were injury or fatality, with almost 87% of these being on the major roadways in the study area. NH Routes 102 and 28 combined accounted for about 2/3 of the total reported crashes, averaging 48 per year, with the Interstate only accounting for 19%, or 25 per year. The traffic circle at NH Route 28 Bypass and NH Route 102 had the most reported crashes of any intersection during this period, averaging almost 5 per year.

Although there was a consistent number of crashes during three of the five years that data was compiled (between 182 and 185 per year), the other two years show wide fluctuations within this period (115 and 52 crashes). Almost 80% of the crashes involved another motor vehicle, with another 13% involving a crash with a fixed object. Seven of the crashes involved a bicyclist or pedestrian, while another six involved a crash with an animal.

TABLE 2

EXIT 4A STUDY AREA CRASH SUMMARY 2010-2014

Location	Fatal Crashes	Injury Crashes	Property Damage Only	Unknown Damage	Total Crashes
Roadways					
NH Route 102, Exit 4 to Tsienneto Road.	1	58	172	9	240
NH Route 28, Exit 5 to NH Route 102	0	40	162	9	211
I-93, Exit 4 to Exit 5	0	27	97	3	127
NH Route 28 Bypass, NH Route 102 to Auburn Town Line	0	19	39	0	58
Folsom Road/Tsienneto Road	0	3	27	2	32
TOTAL	1	147	497	23	668
% OF TOTAL	0.1%	22.0%	74.4%	3.4%	100.0%
AVG PER YEAR	0.2	29.4	99.4	4.6	133.6
Major Intersections					
NH Route 102/NH Route 28 Bypass	0	7	16	0	23
NH Route 28 Bypass/Tsienneto Road	0	3	14	0	17
NH Route 102/NH Route 28	0	3	14	0	17
NH Route 102/Fordway/High St.	0	3	12	0	15
Tsienneto Road/Pinkerton Street	0	1	10	0	11
Folsom Road/Franklin Street	0	1	8	1	10
NH Route 28/Folsom Road/Tsienneto Road/ (Ross' Corner)	0	1	9	0	10
NH Route 28/Ashleigh Dr.	0	3	6	1	10
NH Route 28/Linlew Dr.	0	0	9	0	9
NH Route 102/Londonderry Road	0	2	5	1	8
NH Route 102/Tsienneto Road	0	1	4	0	5
TOTAL	0	25	107	3	135
% OF TOTAL	0.0%	18.5%	79.3%	2.2%	100.0%
AVG PER YEAR	0	5	21.4	0.6	27

ADDITIONAL INFO BELOW

Year					
2010	0	45	132	5	182
2011	0	32	83	0	115
2012	0	45	135	5	185
2013	0	8	40	4	52
2014	1	39	133	9	182
	1	169	523	23	716

23.7% (approx. percent that are injury or fatality)

Crash Types	Number	% Total
Animal	6	0.84%
Bicyclist	2	0.28%
Fixed Object	91	12.71%
Jackknife	1	0.14%
Other Motor Vehicle	568	79.33%
Other Object	3	0.42%
Overturn	14	1.96%
Parked Motor Vehicle	9	1.26%
Pedestrian	5	0.70%
Spill (two-wheeled vehicles)	3	0.42%
Other	14	1.96%
	716	

4.0 Development of Base Traffic Networks

The time periods to be analyzed will be the 2015 AM and PM peak hours as determined by the traffic counts. The analysis will focus on operations of both the Interstate system (freeway facilities, ramp terminals, ramp merge/diverge, weaving sections) as well as local intersection Levels of Service, using the methodologies in the current version of the HCM.

There are two different approaches that need to be considered for the Interstate system versus the local roadways. The Interstate section within the study area from south of Exit 4 to north of Exit 5 is a closed system – traffic enters and exits at specific locations, so the entire system needs to balance in both directions. The local roadways are not a closed system; counts between the local intersections may not necessarily balance in most locations because there are other intervening driveways for adjacent land uses and other minor streets where traffic is able to enter or exit the network.

Interstate Volume Balancing

Within the closed Interstate system, there are two adjustments that need to be made. One is for the overall mainline/ramp system, where a starting point was chosen (in this case, at the NHDOT permanent traffic recorder location south of Exit 4) and add or subtract the on- and off-ramp volumes both northbound and southbound to develop the base AM and PM peak hour networks along I-93.

The second adjustment is to balance volumes between the ramp terminals at both Exits 4 and 5, based on the peak hour volume counts and the recent TMCs that were collected in May 2016. This second process will be discussed later in the report.

Directional counts from the I-93 permanent recorder station during May 2015 were reviewed and compiled to determine the AWDT during that period (taking the Memorial Day holiday count out of consideration). These were adjusted seasonally to develop the 2015 AWDT for both northbound and southbound traffic as the starting point. The ramp counts taken in May 2016 were also seasonally and annually adjusted to the 2015 AWDT and then added and subtracted accordingly going north and south on the Interstate. The resulting mainline 2015 AWDT volumes for the AM and PM peak hours are shown in Figures 4 and 5, respectively. The counts and calculations are provided in Appendix C.

Ramp Terminal Balancing – Exits 4 and 5

The turning movement volumes at the ramp terminals at Exits 4 and 5 must also balance between the intersections while agreeing with the overall ramp volumes. While the ramp volumes were collected with automatic traffic recorders, which only summarized data on an hourly basis, the turning movements were collected at 15-minute intervals. Furthermore, the individual intersections also have their own peak hours, which may not necessarily match the adjacent ramp or the hourly ramp volume. Therefore, an overall peak for each interchange was developed from a summary of the turning movement counts at each location and the turning percentages applied to the balanced interstate ramp volumes derived above. The AM peak period was determined to be from 7:30-8:30, while the PM peak was from 4:45-5:45. The balanced 2015 AM and PM peak hour volumes at the two interchanges are also shown in Figures 4 and 5, respectively. The calculations are also provided in Appendix C.

Other Intersection Counts

As noted above, the local intersection turning movement counts were collected in groups of intersections in close proximity to each other to minimize significant differences between locations, even if there were intervening roadways or driveways that would not allow balancing between sites. There are only four intersections on the local network where traffic should essentially balance between adjacent intersections:

- Between Ross' Corner (NH Route 28/Folsom/Tsienneto) and at Pinkerton Street;
- Between North High Street/Madden Road and the North High Street/Folsom/ Franklin/Franklin Street Extension intersection;
- Between the NH Route 28 Bypass/NH Route 102 traffic circle and the intersection at NH Route 28 Bypass/Pinkerton Street/Perkins Street to the north; and
- Between NH Route 102/Tsienneto Road easterly to include the North Shore Road and English Range Road intersections.

Counts at these locations were balanced and all counts were adjusted to the 2015 AWDT using the NHDOT seasonal and annual factors for Group 4 Urban Highways noted above. The 2015 AM and PM peak hour volumes at the local intersections are shown in Figures 6 and 7, respectively.

5.0 Model Calibration

The SNHPC regional traffic model is an Average Annual Weekday Traffic (AAWDT) model for the greater Manchester, NH area that includes Derry and Londonderry as well as other surrounding towns. The model area has expanded since its use in the 2007 DEIS project to include towns to the south, east and west of the Exit 4A area with added roadway links and TAZs to provide traffic generation capabilities for the SNHPC's planning horizon of 2040.

However, to be a useful travel forecasting tool, the model needs to be able to replicate actual traffic volumes throughout its network within certain reasonable margins of error established by the Federal Highway Administration (FHWA) for regional traffic models. As such, the various 2015 traffic volume counts provided in Table 1 for the Exit 4A study area, among other locations in the SNHPC region, were used as a guide to test the validity of the SNHPC traffic model as a predictive tool of actual 2015 counts found in the region. This was found to be the case, and the findings of the calibration process were presented to the Exi4 4A Working Group in October, 2016. A more detailed memo describing the various calibration procedures undertaken as part of this project is included in Appendix D.

It should be noted that the current SNHPC traffic model is based on expected trip making behavior from observations of past conditions and predicting these out to a future date, in this case the 2040 design year. With the advent of autonomous/connected vehicles (AV/CVs) and the increasing likelihood of them being a larger share of the vehicle fleet within the planning horizon now covered by the model, there is much uncertainty about how and to what extent current and forecasted individual driving habits may be affected by this potentially transformative technology.

A recent study prepared by the Texas A&M Transportation Institute (Texas A&M, 2017) looked at the possible implications of AV/CVs on the transportation planning process. Some of the key modeling components they identified that could be affected by the eventual deployment of AV/CVs into the traffic stream include:

- the possible changes on the socio-economic factors that typically influence trip making and vehicle ownership;
- future characteristics of the highway network, including the effect on roadway and intersection capacity, safety and operations;
- the need to consider changes to the model area geography (e.g. traffic zones) based on possible household locational decisions;
- the possible effects on trip generation, distribution and mode choices with the availability of AV/CVs, including the likelihood of zero-occupant vehicles on the roadway network

The current transportation planning process looks at changes to demographics and roadway networks to predict future travel demands, assuming trip making will be similar to today. With AV/CVs becoming a larger component of future transportation options, the current process is not suited to predict future trip-making behavior since there is no way to reasonably predict the impact of these technologies on individual travel demand decisions. There is also the likelihood that populations that now are unable to drive or own a vehicle will have greater mobility options available to them, and therefore may result in more trips on the network than would normally be forecasted.

Therefore, until such time as traffic demand modelling on a regional basis can account for the increased deployment of AV/CVs at some critical mass to be able to better assess the impact on some/all of the trip-making factors noted above, the current transportation planning and regional travel demand modeling process is the best available option for forecasting future traffic on the roadway network for a project such as Exit 4A.

.

6.0 Capacity Analyses – 2015 Base Conditions

In general, traffic analyses focus on the facilities that present the most likely constraints to overall operations on the roadway network. For interstate facilities, traffic operations are governed largely by the combination of mainline traffic flow at a given speed and number of lanes as it may be influenced by merging and diverging traffic at on and off-ramps at interchanges, as well as any weaving sections between ramps in close proximity to each other. For local roadway networks, traffic flow tends to be governed by intersection capacity which acts to meter volumes onto adjacent roadway segments based on its ability to allow conflicting movemetns to be served.

The *2010 Highway Capacity Manual (TRB, 2010)* provide the technical procedures to analyze traffic operations of freeway facilities (basic freeways, ramp merge/diverge and weaving sections) used in this report. Chapter 10 of the *2010 HCM* defines the methodologies used to analyze typical freeway facility operations for extended lengths of continuously connected basic freeway, weaving, merge and diverge segments, such as those along I-93 in the Exit 4A study area. This methodology allows for the analysis of multiple/continuous 15-minute time periods and is capable of identifying locations where the facility may break down and the impacts of such on the rest of the facility. As such, the analysis determines where the 'weakest link' in the facility may control overall operations along a freeway network in either direction.

The 2000 *Highway Capacity Manual* (TRB, 2000) provided methodologies for signalized and unsignalized intersections, including roundabouts, that will be used to analyze the NH Route 102/NH Route Bypass 28 traffic circle. Because of the phasing and timing limitations of the existing intersections, the HCM 2000 procedures were used for the signalized and unsignalied intersection analyses, as well as to be consistent with the IJR. Chapters 18 and 19 of the *2000 HCM* define the methodologies for signalized and two-way stop controlled intersections.

The Highway Capacity Software (McTrans, 2018) as well as the SYNCHRO/Sim-Traffic programs (Trafficware, 2016) are common software packages used by traffic engineers to evaluate how traffic volumes react under interrupted and uninterrupted flow conditions under various volume, speed, traffic composition, lane use and signal timing conditions. The Level of Service (LOS) criteria for freeway facilities and intersection operations defined in the both versions of the HCM are provided in Appendix E. In general, a LOS C is considered desirable for freeway facilities operations; however, LOS D is considered acceptable for both freeways and intersection operations in urbanized areas.

6.1 Mainline Interstate Operations

The 2015 base weekday AM and PM peak hour volumes along I-93 from just south of Exit 4 to north of Exit 5 are shown in Figures 4 and 5.

The existing two-lane I-93 freeway facility was segmented along its length both northbound and southbound, based on the spacing of on- and off-ramps connecting the basic two-lane freeway segments on either side. Northbound, there were five basic freeway segments, two diverge (i.e., off-ramp) and two merge (i.e. on-ramp) segments under existing conditions. Southbound, there is one additional freeway and one more merge segment to account for the SB loop on-ramp at Exit 4 from the east and the segment between the SB on-ramps. Because of the distance between the existing interchanges, there are currently no weaving sections along I-93 in the Exit 4A study area network.

6.1.1 Mainline Freeway Segments

Five freeway segments are contained in the I-93 project study area going northbound, with a sixth one added in the southbound direction because of the additional on-ramp at Exit 4. There will be additional segments created when the Exit 4A alternatives are analyzed.

The demand and geometric factors input for segments and facility analyses include:

Demand

- Vehicles/hour
- Percent trucks and recreatonal vehicles (RVs)
- Driver population factor

Geometry

- Number of lanes
- Average lane width
- Right-side lateral clearance
- Terrain
- Free-flow speed
- Location of/distance to merge/diverge segments, with number of lanes, length of acceleration/deceleration lanes

A description of the existing facility segments and the detailed reports are summarized in Table 3 and included in Appendix F.

TABLE 3
HCS 2010 - FREEWAY FACILITIES ANALYSIS - 2015 BASE- AM AND PM PEAK HOURS

1-May-17

Segment	Northbound Direction	AM Peak Hour Level of Service (LOS)/d/c ratio BASIC	DIVERGE	MERGE	PM Peak Hour Level of Service (LOS)/d/c ratio BASIC	DIVERGE	MERGE
1	I-93 Mainline south of Exit 4	B/0.45			D/0.77		
2	Exit 4 NB off-ramp		B/0.26			D/0.62	
3	I-93 Mainline between Exit 4 ramps	B/0.36			B/0.50		
4	Exit 4 NB on-ramp			B/0.57			C/0.44
5	I-93 Mainline between Exit 4 NB on- and Exit 5 NB off-ramps	C/0.60			C/0.68		
6	Exit 5 NB off-ramp		C/0.27			C/0.34	
7	I-93 Mainline between Exit 5 ramps	B/0.51			C/0.57		
8	Exit 5 NB on-ramp			D/0.58			D/0.42
9	I-93 Mainline north of Exit 5	D/0.74			D/0.75		
	Facility Operations	C			C		
	Space Mean Speed (mph)	63.2			62.7		
	Density (veh/mi/hr)	19.8			24.4		
Segment	**Southbound Direction**						
1	I-93 Mainline north of Exit 5	D/0.74			D/0.76		
2	Exit 5 SB off-ramp		D/0.50			D/0.50	
3	I-93 Mainline between Exit 5 ramps	C/0.57			C/0.55		
4	Exit 5 SB on-ramp			C/0.31			C/0.25
5	I-93 Mainline between Exit 5 SB on- and Exit 4 SB off-ramps	C/0.69			C/0.65		
6	Exit 4 SB off-ramp		C/0.39			C/0.49	
7	I-93 Mainline between Exit 4 SB off- and SB on ramp from east	B/0.51			B/0.44		
8	Exit 4 SB on-ramp from east			B/0.33			B/0.13
9	I-93 Mainline between Exit 4 SB on-ramps	C/0.63			B/0.49		
10	Exit 4 SB on-ramp from west			C/0.40		B/0.18	
11	I-93 Mainline south of Exit 4	D/0.78			C/0.56		
	Facility Operations	C			C		
	Space Mean Speed (mph)	62.5			62.8		
	Density (veh/mi/hr)	24.4			22.1		

Note: d/c = Demand-to-capacity ratio

6.1.2 Merge/Diverge Operations

Merge/diverge operations are the result of off-ramp and on-ramp traffic leaving and/or getting onto the freeway and how the ramp traffic interacts with the mainline freeway traffic. Since all traffic on I-93 in the study area is entering or exiting in the rightmost lane, which is also where most heavy vehicles travel, this Lane 1 volume is critical to the determination of operations. The ramp spacing and order of operation (e.g. off-ramp followed by an on-ramp, as opposed to an off-ramp followed by another off-ramp) also plays a role in how and to what degree these movements impede mainline freeway traffic flow.

There are currently four merge (on-ramp) and diverge (off-ramp) arrangements in the Exit 4A study area in the northbound direction and a fifth in the southbound direction (the second SB on-ramp at Exit 4). The introduction of a new interchange between Exits 4 and 5 will add another merge and diverge in each direction. The differences between the northerly and southerly interchange alternatives and their relative proximity to Exits 4 and 5 will ultimately determine how these new ramps will affect mainline operations. Table 3 provides the analysis results for the merge/diverge operations along I-93 in the study area under 2015 AM and PM peak hour conditions.

6.1.3 Weaving Operations

Weaving operations occur on highway segments between on- and off-ramps where merging and diverging traffic conflict while completing their respective movements. This analysis is mostly governed by the distance between these ramps, the number of lanes available to make such a movement, the volumes making their respective merge and/or diverge movements, and the ability of these movements to occur independently without influencing each other. This is more of an issue in areas where there are closely spaced interchange ramps.

In the current condition, Exits 4 and 5 are more than two miles apart, so there is essentially no weaving that occurs between the ramps. With the introduction of Exit 4A to the I-93 network, weaving between the Exit 4 NB on-ramp and the Exit 4A NB off-ramp may need to be considered for the southerly interchange alternatives. However, the HCS Freeway Facilities calculations allow for an overlap of the 1500-foot ‘influence areas’ between adjacent ramps, which was included in the analyses. At this point, it does not appear that a weaving section will be created between Exit 4A and Exit 5 because of the greater spacing between them.

7.0 Signalized Intersection Operations – 2015 Base Condition

The existing signal timing/phasing information gathered earlier, combined with the current lane use at each location along with the 2015 AM and PM peak hour volumes, was compiled into a data file in the SYNCHRO (Trafficware, 2016) signal analysis program, which emulates the procedures in Volume 3 (Interrupted Flow) of the *Highway Capacity Manual* 2000 *(HCM)* analysis procedures (TRB, 2000). Because of the phasing and timing limitations of the existing intersections, the HCM 2000 procedures were used for the signalized intersection analyses. The overall delay and LOS was determined by using the HCM module in SYNCHRO, while the queuing calculation results came directly from five runs of the Sim-Traffic module within SYNCHRO per NHDOT guidance (NHDOT, 2017a). The volume-to-capacity (v/c) ratios, average delays and LOS for the signalized intersections are shown in Table 4 below. The peak queues by approach are shown in Table 5 later in this report.

Table 4
Summary of 2015 Signalized Intersection Capacity Analyses

Signalized Intersections							
		AM Peak Hour			**PM Peak Hour**		
Intersection	**Existing Lane Use**	**v/c**	**Delay**	**LOS**	**v/c**	**Delay**	**LOS**
#1 - Exit 4 SB Off-Ramp/NH Route 102	**EB-** T, T; **WB-** T, T **SB-** L, R	0.55	17.7	B	0.67	40.2	D
#2 - Exit 4 NB Off-Ramp/NH Route 102	**EB-** L, T, T; **WB-** T, T, R **NB-** L, L, R	0.86	34.6	C	0.71	29.8	C
#3 - Exit 5 SB Off-Ramp/NH Route 28	**EB-** T, T, R; **WB-** L, T, T **SB-** L, L, R	0.74	21.0	C	0.63	21.8	C
#4 - Exit 5 NB Off-Ramp/NH Route 28	**EB-** L, T, T; **WB-** T, T, R **NB-** L, R	0.78	15.9	B	0.66	20.3	C
#6 - NH Route 102/Fordway	**EB-** T, R; **WB-** L/T; **NB-** L/R; **SB-** L/T/R	0.89	25.7	C	0.94	34.1	C
#7 - NH Routes 102/28	**EB-** L,T/R; **WB-** L,T/R; **NB-** L,T/R; **SB-** L, T, R	0.84	39.9	D	0.83	39.9	D
#11- Ross' Corner (Folsom/NH Route 28)	**EB-** L,T,R; **WB-** L,T,R; **NB-** L, T, T, R; **SB-** L, T, T, R	0.61	37.1	D	0.78	47.2	D
#13 -NH Route 28/Linlew Drive	**EB-** L/T, R; **WB-** L/T, R; **NB-** L, T, T/R; **SB-** L, T, T/R	0.41	13.3	B	0.61	18.9	B
#14 - NH Route 28/Ashleigh Drive	**EB-** L,T/R; **WB-** L, L/T, R; **NB-** L, T, T/R; **SB-** L, L, T, T,/R	0.48	16.9	B	0.72	24.0	C
#18 - NH Route 28 Bypass/ Tsienneto Road	**EB-** L,T/R; **WB-** L,T/R; **NB-** L,T/R; **SB-** L, T, R	0.80	36.5	D	0.83	35.4	D

The HCM and SYNCHRO printouts are provided in Appendices G 1-3.

The results of these analyses show which movements at the various intersections exhibit some current capacity constraints (LOS E or worse). Some of these, such as at the Exit 4 ramp terminals, will be addressed by the ongoing I-93 widening project, while issues at other local intersections may need to be addressed in some form, either through added lanes and/or optimized signal timings, by the 2040 design year. These existing deficiencies are discussed briefly below:

- Exit 4 SB Off-Ramp

  The turns from the off-ramp are the most constrained movements, with the higher-volume right turn from a single lane showing the most delay and queuing. A second right-turn lane is proposed as part of the ongoing improvements to Exit 4.

- Exit 4 NB Ramps

  The westbound thru traffic is under duress during the AM peak, while the eastbound left turn to the on-ramp is at LOS E in the PM peak. While the right turn from the off-ramp operates at a good LOS because it is not controlled by the signal, field observations show it is often impeded by either the eastbound traffic through the intersection and/or the downstream queuing of traffic on NH Route 102 east of the interchange.

- NH Route 102/NH Route 28 (Crystal Avenue/Broadway/Birch Street)

  This major crossroads in the heart of downtown Derry has several movements that exhibit substantial delays during AM and/or PM peak hours, and results in queuing along Broadway. The level of parking and pedestrian activity also affects overall traffic operations as the mix of local and through traffic results in significant congestion, even if not directly reflected in the overall capacity/LOS calculations.

  Because the reduction in this through traffic in downtown Derry is one of the primary purposes for the proposed Exit 4A project, it was necessary to find a more qualitative assessment of downtown congestion that may not be reflected in the capacity calculations. To do this, we looked at Google Maps snapshots during the course of typical weekday AM and PM peak hours (Google, 2018). These are based on real-time on-the-ground observations of travel times in the study area. The snapshots for AM and PM peak hours between Monday, January 22, 2018 and Friday, January 26, 2018 are provided in Appendix H. It should be noted that Exit 4 is currently under construction, although there should be minimal work going on during the winter when these snapshots were taken.

  These figures show regular congestion at the NH Route 102/28 intersection as well as other key intersections in the study area during any given weekday peak hour. Congestion in and around Exit 4 is oriented westbound in the AM peak and eastbound in the PM peak, and is shown to affect other segments along Broadway in both directions to varying degrees. Key intersections along the north-south corridors of NH Route 28 and NH Route 28 Bypass, such as at Ross' Corner, Tsienneto Road, and the traffic circle at NH Route 102, appear to exhibit regular levels of delay and congestion based on this sample of peak hour travel times.

- Ross' Corner (NH Route 28/Tsienneto Road/Folsom Road)

  This intersection leads to the major commercial corridor in north Derry as well as serving as a commuter route. Traffic currently uses the Ash Street Extension and Folsom Road as an alternative route to NH Route 102 to avoid the aforementioned downtown congestion. Several turning movements experience significant delays, even with recent improvements that provided a second SB left-turn lane onto Tsienneto Road. The proximity of the Pinkerton Street unsignalized intersection just east of this location also affects overall traffic flow in this area.

- NH Route28/Ashleigh Drive

  This intersection serves as the primary access drive to the new Wal-Mart supercenter as well as other commercial establishments on the east side of NH Route 28. The heavy turning movements into and out of this town road, combined with significant commuter volumes along the NH Route 28 corridor, result in less than desirable levels of delay for several movements, particularly in the PM peak, even though the overall LOS is at LOS C.

- NH Route 28 Bypass/Tsienneto Road

  The Tsienneto Road corridor west of NH Route 28 Bypass as well as the lands adjacent to this intersection has seen a fair share of new development over the years, as well as increased use by east-west commuter traffic avoiding NH Route 102 and the downtown area. With only a single east-west lane through the intersection, calculated delays now exceed acceptable LOS thresholds for some movements during both peaks.

8.0 Unsignalized Intersection Operations

Similarly, the unsignalized intersections in the study area network were analyzed for the 2015 AM and PM peak hours using the standard 2010 HCM procedures. These results are provided in Table 6, with the printouts in Appendix I. It should be noted that the traffic circle at the intersection of NH Route 28 Bypass, NH Route 102, and East Derry Road was analyzed as a roundabout, since all turns at this location are right turns in the counterclockwise direction. The circle was evaluated using updated roundabout analysis procedures from HCM 6, published in 2016 (TRB, 2016), because it incorporates updated data from actual field operations of the growing number of roundabouts in the USA and, as such, should be more representative of local driver behavior.

As observed in the field and confirmed by the SYNCHRO analyses, left turns from the minor side streets experience significant delays due to the high volumes on the major streets, either on the State highway system or local streets such as Tsienneto Road. Of particular concern is the heavy left-turn volume exiting from Pinkerton Street onto Tsienneto Road in close proximity to the signalized intersection at Ross' Corner. Special attention will be needed to address this condition under future No-Build and Build conditions.

The table also shows the peak design queue by approach for both the signalized and unsignalized intersections, based on the 2015 capacity analysis of base conditions. This will be an important component of evaluating the future 2040 Build condition layouts under the various alternatives.

Table 5
2015 Signalized Intersection Capacity and Queuing Analyses

Signalized Intersections

		AM Peak Hour				PM Peak Hour			
Intersection	Lane Groups	95% queue (ft)	v/c ratio	Average Delay	LOS	95% queue (ft)	v/c ratio	Average Delay	LOS
#1 - Exit 4 SB Off-Ramp/NH Route 102	EB Thru	212	0.46	11.5	B	230	0.44	11.0	B
	WB Thru	18	0.31	1.9	A	18	0.41	1.8	A
	SB LT	251	0.64	39.5	D	317	0.69	50.4	D
	SB RT	176	0.75	13.6	B	630	1.08	80.9	F
#2 - Exit 4 NB Off-Ramp/NH Route 102	NB LT	107	0.57	46.2	D	281	0.50	33.3	C
	NB RT	0	0.15	0.2	A	0	0.41	0.8	A
	EB LT	610	0.88	43.8	D	548	0.91	62.3	E
	EB Thru	83	0.24	4.3	A	242	0.40	19.5	B
	WB Thru	448	0.97	58.7	E	250	0.76	51.5	D
#3 - Exit 5 SB Off-Ramp/NH Route 28	EB Thru	212	0.68	32.7	C	197	0.56	27.8	C
	EB RT	0	0.21	0.3	A	0	0.21	0.3	A
	WB LT	211	0.81	40.0	D	151	0.62	45.3	D
	WB Thru	59	0.43	7.0	A	52	0.28	4.8	A
	SB LT	138	0.68	29.2	C	254	0.73	36.5	D
	SB RT	148	0.78	28.7	C	63	0.45	6.2	A
#4 - Exit 5 NB Off-Ramp/NH Route 28	EB LT	251	0.86	55.0	D	223	0.72	48.4	D
	EB Thru	5	0.44	2.2	A	308	0.53	12.7	B
	WB Thru	189	0.56	26.1	C	192	0.37	27.4	C
	WB RT	0	0.53	1.3	A	0	0.38	0.7	A
	NB LT	233	0.87	49.4	D	180	0.75	44.1	D
	NB RT	0	0.10	0.1	A	143	0.77	35.2	D
#6 - NH Route 102/Fordway	EB all	247	0.12	17.7	B	591	1.00	47.1	D
	WB all	368	0.94	26.4	C	306	0.81	26.8	C
	NB all	304	0.72	51.7	D	215	0.84	36.6	D
	SB all	22	0.86	12.4	B	90	0.18	15.9	B
#7 - NH Routes 102/28	EB L	148	0.83	83.0	F	155	0.70	55.8	E
	EB T/R	170	0.42	20.1	C	393	0.73	34.2	C
	WB L	47	0.28	40.6	D	119	0.68	69.5	E
	WB T/R	385	0.88	42.7	D	272	0.67	35.1	D
	NB L	101	0.79	90.6	F	80	0.43	42.5	D
	NB T/R	274	0.85	48.3	D	316	0.86	51.3	D
	SB L	121	0.86	103.4	F	174	0.79	67.9	E
	SB Thru	188	0.61	33.9	C	346	0.77	43.3	D
	SB RT	2	0.23	1.1	A	35	0.21	3.5	A

Table 5 (Cont'd)

Signalized Intersections (cont.)

Intersection	Existing Lane Use	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay	PM LOS
#11- Ross' Corner (Folsom/NH Route 28)	EB L	191	0.16	88.0	F	324	0.89	78.7	E
	EB Thru	169	0.27	45.1	D	310	0.73	49.0	D
	EB R	0	0.25	0.0	A	0	0.17	0.7	A
	WB L	157	0.70	66.1	E	273	1.14	165.5	F
	WB Thru	323	0.21	80.3	F	241	0.75	60.7	E
	WB R	108	0.26	8.0	A	190	0.52	16.4	B
	NB L	35	0.90	40.5	D	134	0.58	66.6	E
	NB Thru	90	0.63	25.5	C	198	0.43	40.0	D
	NB R	0	0.01	1.2	A	0	0.27	1.1	A
	SB L	131	0.74	42.0	D	248	0.76	49.7	D
	SB Thru	72	0.95	19.5	B	419	0.64	35.6	D
	SB RT	27	0.48	4.1	A	51	0.28	4.8	A
#13 -NH Route 28/Linlew Drive	EB L/T	10	0.06	33.0	C	40	0.18	39.4	D
	EB R	0	0.04	0.2	A	0	0.05	0.3	A
	WB L/T	61	0.35	40.6	D	69	0.46	48.8	D
	WB R	93	0.71	18.9	B	43	0.66	13.0	B
	NB L	0	0.00	0.0	A	36	0.19	46.3	D
	NB T/R	675	0.35	12.9	B	296	0.50	15.5	B
	SB L	63	0.35	42.8	D	125	0.64	37.4	D
	SB T/R	134	0.38	4.9	A	437	0.57	14.3	B
#14 - NH Route 28/Ashleigh Drive	EB L	20	0.12	40.8	D	60	0.54	65.2	E
	EB T/R	16	0.11	30.0	C	29	0.25	34.5	C
	WB L	110	0.52	46.5	D	232	0.84	69.2	E
	WB L/T	111	0.53	46.7	D	227	0.83	67.0	E
	WB R	38	0.22	6.0	A	63	0.29	10.9	B
	NB L	56	0.05	61.6	D	3	0.06	65.0	E
	NB T/R	183	0.50	10.1	B	311	0.69	14.8	B
	SB L	8	0.41	42.9	E	39	0.47	47.4	D
	SB T/R	285	0.35	10.3	B	234	0.60	14.0	B
#18 - NH Route 28 Bypass/ Tsienneto Road	EB L	126	0.88	77.5	E	278	0.86	54.0	D
	EB T/R	114	0.49	24.2	C	394	0.69	30.0	C
	WB L	82	0.50	41.9	D	36	0.15	35.1	D
	WB T/R	309	0.95	59.4	E	248	0.86	58.0	E
	NB L	119	0.70	57.5	E	97	0.53	44.2	D
	NB T/R	193	0.48	26.8	C	307	0.69	37.0	D
	SB L	36	0.18	35.8	D	80	0.44	42.4	D
	SB Thru	171	0.63	35.7	D	149	0.39	29.4	C
	SB R	71	0.41	7.9	A	30	0.20	2.3	A

Table 6
2015 Unsignalized Intersection Capacity and Queuing Analyses

Intersection	Existing Lane Use	AM Peak Hour 95% queue (ft)	AM v/c ratio	AM Average Delay	AM LOS	PM Peak Hour 95% queue (ft)	PM v/c ratio	PM Average Delay	PM LOS
#5 - NH Route 102/Londonderry Road	EB L	13	0.142	12.3	B	40	0.354	11.7	B
	WB L	0	0.005	8.6	A	0	0.008	10.7	B
	NB all	0	0.008	11.9	B	65	1.078	*	F
	SB L/T	20	0.253	115.0	F	68	1.130	*	F
	SB R	65	0.505	36.1	E	45	0.395	19.9	C
#8 - North High Street/Ash Street Extension	EB all	45	0.383	15.4	C	445	1.152	123.5	F
	NB LT	0	0.005	8.2	A	0	0.005	8.4	A
#9 - North High Street/Madden Road	EB all	8	0.079	18.7	C	10	0.11	27.2	D
	NB LT	0	0.000	0.0	A	0	0.00	0.0	A
#10 – North High/Folsom/Franklin Streets	EB all	3	0.035	8.3	A	3	0.043	8.4	A
	WB all	3	0.025	8.0	A	3	0.038	9.2	A
	NB all	15	0.160	14.2	B	30	0.293	23.7	C
	SB all	8	0.096	10.5	B	50	0.424	22.5	C
#12 - Tsienneto Road/Pinkerton Street	WB L	8	0.088	8.5	A	13	0.138	9.3	A
	WB L/T	0	0.000	0.0	A	0	0.000	0.7	A
	NB L	309	1.156	154.3	F	340	1.424	282.3	F
	NB R	13	0.154	11.8	B	28	0.279	15.0	C
#15 - NH Route 28/Scobie Pond Road	EB L	3	0.022	9.5	A	5	0.061	10.3	B
	SB all	183	1.011	143.2	F	318	2.116	*	F
#16 - NH Route 102/NH Route 28 Bypass/East Derry Road (Traffic Circle-RT only)	EDR WB	375	1.031	77.5	F	450	1.112	103.3	F
	28 Byp NB	175	0.781	29.5	D	525	1.268	169.4	D
	28 Byp SB	400	1.058	83.5	F	750	1.250	146.4	F
	102 EB	475	1.106	96.6	F	850	1.456	240.0	F
	102 WB	325	1.026	86.1	F	100	0.622	24.6	C
#17 - NH Route 28Bypass/ Pinkerton/Nesmith	EB L/T	125	3.388	*	F	60	0.521	69.4	F
	EB R	40	0.350	13.6	B	140	0.692	20.6	C
	WB all	245	1.371	296.3	F	73	0.599	76.5	F
	NB all	30	0.289	9.5	A	15	0.175	8.5	A
	SB all	0	0.014	8.5	A	3	0.025	8.4	A
#19 - NH Route 102/Tsienneto Road	EB L	3	0.020	9.5	A	0	0.016	8.4	A
	SB L/R	30	0.287	19.3	C	218	0.869	60.9	F

Note- Assumes 25 ft per queued vehicle
* - calculated delay exceeds 300s

9.0 Summary of SNHPC Model Assignments – 2015, 2040

The SNHPC calibration of their regional traffic forecasting model was discussed with the Traffic Working Group (TWG) in October 2016. This calibration process was based on the least-mean squared comparison of the 2015 assignments (based on the various socioeconomic characteristics of each Traffic Analysis Zone (TAZ) used by the model to generate origins and destinations to be assigned to the network) to the calculated 2015 Average Annual Weekday Traffic (AAWDT) on the key links in the study area network that were derived from the extensive traffic counting program initiated at the start of this SDEIS project. This comparison was found to fall within the FHWA's acceptable margin of error for traffic modeling as summarized in Appendix D. **As such, it was agreed by the TWG at this meeting that the model was in compliance with FHWA standards for model accuracy and could be used as a tool to reasonably project future volumes for this project.**

It was further agreed by the TWG that the relative differences between the model AAWDT assignments for 2015 and 2040 would be applied to the calculated 2015 AAWDT volumes. AM and PM peak hour volumes were to be derived as a percentage of the AAWDT as determined in both the roadway and intersection turning movement count data. AAWDT assignments at individual intersections would be used to develop any adjustments to peak hour existing turning movements, based on both the increase/decrease in traffic volume as well as any changes in turning movement percentages of any particular movement. The derivation of these future intersection volumes was completed only after consensus was reached with the TWG on the reasonableness of the 2040 AAWDT traffic assignments for each alternative.

The future model includes known/programmed roadway improvements in the SNHPC's Regional Transportation Plan - 2015-2040 (SNHPC, 2017) that includes Exit 4A; however, this interchange was not included in any of the No-Build networks. While it was recognized that there may be locations where existing/projected capacity deficiencies may exist, only those projects either programmed in the State's Ten-Year Highway Plan (NHDOT, 2018) or the Regional Transportation Plan were included in the 2040 No-Build network.

The 2040 SNHPC model assignments were developed by including the population and employment projections for each community in the SNHPC model area, as outlined in the Lane Use Scenarios report (Louis Berger, 2017) and disaggregated to the TAZ level. This report also included alternative development scenarios without and with the proposed Exit 4A interchange, notably for the Woodmont Commons development on the east side of I-93, since the development of that parcel would be directly impacted by the location of the proposed interchange. In general, the Woodmont Commons–East development was assumed to reach its build-out potential under only the southerly interchange options (A and B), and would have a lesser development scenario under the 2040 No-Build C, D, and F alternatives.

It should also be noted that the Woodmont Commons traffic impact study for the full development project submitted to the Town of Londonderry (TEC, 2013) assumed that, because of the ‘live-work-play’ design intent of the proposed mixed-use development, a certain percentage of site-generated trips would remain ‘internally captured’ within the site itself and would not be assigned to the adjacent street network outside of the development. An adjustment factor of 23% was applied to the total site traffic generation for the various proposed land uses assumed in the Woodmont Commons traffic impact study to account for this estimated internal capture rate.

However, it should be noted that the methodologies used to develop trip generation, distribution and assignments for an individual traffic impact study versus a regional model are quite different. The model applies its trip distribution and assignment algorithms directly to the trip productions and attractions generated by each TAZ, based on their socioeconomic characteristics, which does not differentiate between trips that should or should not be assigned to other TAZs. In addition, the Woodmont Commons development is included as part of several TAZs, so correcting for only some trips from a particular TAZ and not others may appear to be arbitrary and jeopardize the validity of the model.

After consultation with the NHDOT Bureau of Traffic, it was agreed, as the initial step, all the model-generated traffic from all TAZs, including Woodmont Commons, was assigned to the SNHPC model network without regard to the internal capture rate assumptions noted in their site-specific traffic impact study. (NHDOT, 2017b) This should provide a conservatively worst-case estimate of traffic being assigned to the study area roadway network. Should the design intent of Woodmont Commons be realized and less traffic is actually generated as the project evolves, overall operations would be better than projected and the design life of any proposed improvements would be extended.

Individual spreadsheets were created for the key links in the network under each 2040 alternative for purposes of calculating the projected 2040 AAWDT and AM and PM peak hour volumes, based on the relative increase/decrease between 2015 and 2040 model assignments.

9.1 AAWDT Comparisons – 2040

Table 7 presents a summary of the projected 2040 AAWDT on key links in the study area roadway network, including the I-93 mainline and all interchange ramps. As noted above, these were derived by applying the growth rate between SNHPC’s 2015 and 2040 model assignments to the calculated 2015 AAWDT derived from the updated traffic counting program created for this project. These assignments also provide projected volumes for newly created road segments, including the Exit 4A on- and off-ramps as well as the connector roadway between the new proposed interchange and the existing roadway network.

TABLE 7

Adjusted 2040 AAWDT volume comparison - All Alternatives

7-Apr-17

rev 1-26-18

	Loc Code	Count Location	Raw 2015 AAWDT	Adj 2015 AAWDT	2015 AAWDT Base Model Assigns	2040 AAWDT No-Build Assigns	% Growth to '15 base No-Build 2015-40	2040 No-Build AAWDT	2040 AAWDT Alt A Assigns	% Growth to '15 base Alt A 2015-40	2040 Alt A AAWDT	AAWDT Difference Alt A vs No-Build	2040 AAWDT Alt B Assigns	% Growth to '15 base Alt B 2015-40	2040 Alt B AAWDT	AAWDT Difference Alt B vs No-Build	2040 AAWDT Alt C Assigns	% Growth to '15 base Alt C 2015-40	2040 Alt C AAWDT	AAWDT Difference Alt C vs No-Build	2040 AAWDT Alt D Assigns	% Growth to '15 base Alt D 2015-40	2040 Alt D AAWDT	AAWDT Difference Alt D vs No-Build	2040 AAWDT Alt F Assigns	% Growth to '15 base Alt F 2015-40	2040 Alt F AAWDT	AAWDT Difference Alt F vs No-Build
		Derry Locations																										
Derry	1	Crystal Av (NH 28), S of Tsienneto	15,585	15,195	13,406	10,220	-23.77%	11,584	7,242	-45.98%	8,208	-29.1%	10,565	-21.19%	11,975	3.4%	12,279	-8.41%	13,918	20.1%	13,225	-1.35%	14,990	29.4%	10,313	-23.07%	11,689	0.9%
	2	Folsom Rd W of NH 28	12,070	11,768	8,960	10,537	17.60%	13,839	29,612	230.49%	38,892	181.0%	4,730	-47.21%	6,212	-55.1%	9,494	5.96%	12,469	-9.9%	8,646	-3.50%	11,356	-17.9%	9,223	2.94%	12,113	-12.5%
	3	Pinkerton St E of Tsienneto	10,722	10,454	8,776	6,396	-27.12%	7,619	9,059	3.22%	10,791	41.6%	9,178	4.58%	10,933	43.5%	11,138	26.91%	13,268	74.1%	11,608	32.27%	13,827	81.5%	6,356	-27.58%	7,571	-0.6%
	4	Tsienno Rd, W of NH 102	5,532	5,394	5,666	9,072	60.11%	8,636	10,824	91.03%	10,304	19.3%	16,182	185.60%	15,405	78.4%	15,529	174.07%	14,784	41.6%	11,363	100.55%	10,818	25.3%	9,191	62.21%	8,750	1.3%
	5	Tsienneto Rd E of Pinkerton	15,012	14,637	14,200	18,876	32.93%	19,457	22,226	56.52%	22,910	17.7%	15,241	7.33%	15,710	-19.3%	15,644	10.17%	16,125	-17.1%	20,041	41.13%	20,658	6.2%	18,976	33.63%	19,560	0.5%
	6	NH 102, E of NH 28 Bypass	7,456	7,270	7,016	6,126	-12.69%	6,348	6,924	-1.31%	7,175	13.0%	4,277	-39.04%	4,432	-30.2%	3,324	-52.62%	3,444	-45.7%	5,942	-15.31%	6,157	-3.0%	6,450	-8.07%	6,684	5.3%
	7	NH 28 Byp, N of Academy Dr	8,615	8,400	7,318	2,853	-61.01%	3,275	2,333	-68.12%	2,678	-18.2%	2,375	-67.55%	2,726	-16.8%	2,436	-66.71%	2,796	-14.6%	2,420	-66.93%	2,778	-15.2%	2,785	-61.94%	3,197	-2.4%
	8	NH 28 Byp, N of Tsienneto Rd	12,250	11,944	9,377	4,072	-56.57%	5,187	4,229	-54.90%	5,387	3.9%	2,696	-71.25%	3,434	-33.8%	2,290	-75.58%	2,917	-43.8%	4,218	-55.02%	5,373	3.6%	4,145	-55.80%	5,280	1.8%
	9	NH 28 Byp, S of Thornton Rd S.	14,341	13,982	12,227	7,327	-40.08%	8,379	7,652	-37.42%	8,750	4.4%	7,791	-36.28%	8,909	6.3%	8,741	-28.51%	9,996	19.3%	8,136	-33.46%	9,304	11.0%	7,191	-41.19%	8,223	-1.9%
	10	NH 102 E of Griffin St	16,000	16,820	18,002	20,810	15.60%	19,444	16,885	-6.20%	15,776	-18.9%	16,759	-6.90%	15,659	-19.5%	16,330	-9.29%	15,258	-21.5%	18,591	3.27%	17,370	-10.7%	24,147	34.14%	22,562	16.0%
	11	NH 102 W of Abbot St	14,000	14,350	11,128	14,902	33.91%	19,217	15,442	38.77%	19,913	3.6%	11,283	1.39%	14,550	-24.3%	9,968	-10.42%	12,854	-33.1%	11,885	6.80%	15,326	-20.2%	15,829	42.24%	20,412	6.2%
	12	Fordway over Beaver Brook	5,200	5,330	5,114	3,511	-31.35%	3,659	4,748	-7.16%	4,949	35.3%	4,273	-16.45%	4,453	21.7%	4,206	-17.76%	4,384	19.8%	3,926	-23.23%	4,092	11.8%	3,595	-29.70%	3,747	2.4%
	13	Franklin St Ext, N. of Folsom Rd	1,800	1,845	1,254	1,959	56.22%	2,882	1,367	9.01%	2,011	-30.2%	4,736	277.67%	6,968	141.8%	2,083	66.11%	3,065	6.3%	2,019	61.00%	2,971	3.1%	1,783	42.19%	2,623	-9.0%
	14	Ash St at Londonderry town line	6,600	6,765	5,936	13,790	132.31%	15,716	6,065	2.17%	6,912	-56.0%	5,923	-0.22%	6,750	-57.1%	8,843	48.97%	10,078	-35.9%	8,511	43.38%	9,700	-38.3%	12,825	116.05%	14,616	-7.0%
	15	Crystal Av (NH 28), S of Rollins St	13,000	13,000	13,215	10,463	-20.82%	10,293	11,087	-16.10%	10,907	6.0%	11,110	-15.93%	10,929	6.2%	11,753	48.97%	10,078	-2.1%	11,998	-9.21%	11,803	14.7%	11,022	-16.59%	10,843	5.3%
		NH 102, at Derry/Chester town line	8,200	8,200	10,839	12,783	17.94%	9,671	14,181	30.83%	10,728	10.9%	14,668	35.33%	11,097	14.7%	14,002	-11.06%	11,562	19.6%	14,138	30.44%	10,696	10.6%	12,808	18.17%	9,690	0.2%
		Londonderry Locations																										
L-derry	16	NH 102, E of Hampton Dr	32,000	32,000	30,418	51,401	68.98%	54,074	56,306	85.11%	59,234	9.5%	56,263	84.97%	59,189	9.5%	50,680	66.61%	53,316	-1.4%	51,066	67.88%	53,722	-0.7%	52,565	72.81%	55,299	2.3%
	17	NH 102, E of Exit 4		26,800	20,818	32,410	55.68%	41,723	15,723	-24.47%	20,241	-51.5%	16,852	-19.05%	21,694	-48.0%	18,986	-8.80%	24,442	-41.4%	20,775	-0.21%	26,745	-35.9%	34,151	64.05%	43,964	5.4%
	18	NH 102 at Derry/L'derry Town line	22,656	22,090	22,983	29,904	30.11%	28,742	20,413	-11.18%	19,620	-31.7%	20,908	-9.03%	20,096	-30.1%	21,661	-5.75%	20,819	-27.6%	23,215	1.01%	22,313	-22.4%	32,520	41.50%	31,256	8.7%
	19	NH 28 at Derry/L'derry Town line	17,324	16,891	19,392	15,638	-19.36%	13,621	9,440	-51.32%	8,223	-39.6%	8,125	-58.10%	7,077	-48.0%	42,458	118.95%	36,982	171.5%	40,462	108.65%	35,244	158.7%	15,477	-20.19%	13,481	-1.0%
	20	NH 28 N of Liberty Dr	13,000	13,000	15,406	14,733	-4.37%	12,432	9,984	-35.19%	8,425	-32.2%	8,697	-43.55%	7,339	-41.0%	4,904	-68.17%	4,138	-66.7%	4,757	-69.12%	4,014	-67.7%	14,584	-5.34%	12,306	-1.0%
	21	Gilcreast Rd N of NH 102	10,070	9,818	9,397	16,438	74.93%	17,174	15,318	63.01%	16,004	-6.8%	15,035	60.00%	15,709	-8.5%	15,112	60.82%	15,789	-8.1%	14,742	56.88%	15,402	-10.3%	16,006	70.33%	16,723	-2.6%
	22	Londonderry Rd, N of NH 102		4,622	4,742	4,823	1.71%	4,701	6,536	37.83%	6,371	35.5%	6,034	27.25%	5,881	25.1%	7,633	60.97%	7,440	58.3%	7,354	55.08%	7,168	52.5%	4,521	-4.66%	4,407	-6.3%
	23	Ash St E of Londonderry Rd	6,900	6,900	5,949	14,001	135.35%	16,239	6,065	1.95%	7,035	-56.7%	5,923	-0.44%	6,870	-57.7%	8,682	45.94%	10,070	-38.0%	8,457	42.16%	9,809	-39.6%	13,023	118.91%	15,105	-7.0%
		Connector Rd, E. of Exit 4A (L'derry)	-	-					53,720				54,523				38,516				36,728				0			
		Connector Rd, W. of N High St (Derry)	-	-					40,974																			
		Connector Rd, W. of NH 28 (Derry)	-	-									35,565															
		Connector Rd, E. of NH 28 (Derry)	-	-									16,193				13,888											
		Connector Rd, N. of NH 102 (Derry)											16,182				15,529											
	24	Exit 4 NB Off-ramp	10,249	9,993	10,389	20,215	94.58%	19,444	18,073	73.96%	17,384	-10.6%	18,135	74.56%	17,444	-10.3%	18,728	80.27%	18,014	-7.4%	19,497	87.67%	18,754	-3.5%	20,417	96.53%	19,639	1.0%
	25	Exit 4 NB On-ramp	10,303	10,045	9,550	21,343	123.49%	22,449	15,150	58.64%	15,935	-29.0%	17,638	84.69%	18,552	-17.4%	15,903	66.52%	16,727	-25.5%	15,411	61.37%	16,210	-27.8%	21,378	123.85%	22,486	0.2%
	26	Exit 4 SB Off-ramp	9,862	9,615	8,157	18,349	124.95%	21,629	13,795	69.12%	16,261	-24.8%	14,795	81.38%	17,439	-19.4%	12,694	55.62%	14,963	-30.8%	12,431	52.40%	14,653	-32.3%	18,730	129.62%	22,078	2.1%
	27	Exit 4 SB On-ramp - EB to SB	5,310	5,177	4,907	10,778	119.65%	11,371	11,836	141.21%	12,487	9.8%	11,659	137.60%	12,301	8.2%	10,850	121.11%	11,447	0.7%	10,881	121.74%	11,480	1.0%	10,705	118.16%	11,294	-0.7%
	28	Exit 4 SB On-ramp - WB to SB	4,767	4,648	3,637	7,402	103.52%	9,460	3,879	6.65%	4,957	-47.6%	4,125	13.42%	5,272	-44.3%	5,140	41.33%	6,569	-30.6%	5,152	41.66%	6,584	-30.4%	7,494	106.05%	9,577	1.2%
		Exit 4A NB Off-ramp	-	-					8,732		8,732		9,488		9,488		2,795		2,795		1,504		1,504					
		Exit 4A NB On-ramp	-	-					15,240		15,240		13,208		13,208		13,410		13,410		13,630		13,630					
		Exit 4A SB Off-ramp	-	-					18,996		18,996		19,376		19,376		17,290		17,290		16,972		16,972					
		Exit 4A SB On-ramp	-	-					10,752		10,752		12,450		12,450		5,021		5,021		4,621		4,621					
																									6,256			
	29	Exit 5 NB Off-ramp	5,745	5,601	4,430	6,401	44.49%	8,093	7,521	69.77%	9,509	17.5%	7,036	58.83%	8,896	9.9%	6,626	49.57%	8,377	3.5%	7,054	59.23%	8,919	10.2%	13,329	41.22%	7,910	-2.3%
	30	Exit 5 NB On-ramp	9,580	9,341	9,101	13,499	48.32%	13,855	10,863	19.36%	11,149	-19.5%	10,468	15.02%	10,744	-22.5%	7,829	-13.98%	8,035	-42.0%	7,985	-12.26%	8,196	-40.8%	12,249	46.46%	13,680	-1.3%
	31	Exit 5 SB Off-ramp	9,520	9,282	9,234	13,577	47.03%	13,648	7,670	-16.94%	7,710	-43.5%	6,036	-34.63%	6,067	-55.5%	5,728	-37.97%	5,758	-57.8%	5,790	-37.30%	5,820	-57.4%	5,882	32.65%	12,313	-9.8%
	32	Exit 5 SB On-ramp	5,645	5,504	3,919	5,884	50.14%	8,264	6,879	75.53%	9,661	16.9%	5,355	36.64%	7,521	-9.0%	5,916	50.96%	8,309	0.5%	5,879	50.01%	8,257	-0.1%		50.09%	8,261	0.0%
		I-93, south of Exit 4 (DOT PATR)		71,060	72,378	118,908	64.29%	116,743	123,109	70.09%	120,867	3.5%	123,558	70.71%	121,308	3.9%	119,322	64.86%	117,149	0.3%	119,380	64.94%	117,206	0.4%	119,129	64.59%	116,960	0.2%
		NB			36,417	59,234	62.65%	-	61,455	68.75%	-		61,615	69.19%	60,470		59,601	63.66%	-		59,527	63.46%	-		59,424	63.18%	-	
		SB			35,961	59,674	65.94%	-	61,654	71.45%	-		61,943	72.25%	60,839		59,721	66.07%	-		59,853	66.44%	-		59,705	66.03%	-	
		I-93, between Exits 4 and 4A		71,000	71,152	120,205	68.94%	119,948	118,266	66.22%	118,013	-1.6%	122,072	71.57%	121,811	1.6%	113,200	59.10%	112,958	-5.8%	111,723	57.02%	111,484	-7.1%	120,621	69.53%	120,363	0.3%
		NB			35,578	60,363	69.66%	0	58,532	64.52%	-		61,119	71.79%	-		56,776	59.58%	-		55,441	55.83%	-		60,385	69.73%	-	
		SB			35,574	59,842	68.22%	0	59,734	67.91%	-		60,953	71.34%	-		56,424	58.61%	-		56,282	58.21%	-		60,236	69.33%	-	
		I-93, between Exits 4A and 5		71,000	71,152	120,205	68.94%	119,948	133,018	86.95%	132,734	10.7%	132,718	86.53%	132,434	10.4%	136,083	91.26%	135,792	13.2%	136,200	91.42%	135,909	13.3%	120,621	69.53%	120,363	0.3%
		NB			35,578	60,363	69.66%	-	65,040	82.81%			64,839	82.24%			67,390	89.41%			67,567	89.91%			60,385	69.73%	-	
		SB			35,574	59,842	68.22%	-	67,978	91.09%			67,879	90.81%			68,693	93.10%			68,633	92.93%			60,236	69.33%	-	
		I-93, north of Exit 5		76,000	81,139	134,995	66.37%	126,445	137,153	69.03%	128,466	1.6%	136,851	68.66%	128,183	1.4%	137,099	68.97%	128,416	1.6%	137,042	68.90%	128,362	1.5%	135,061	66.46%	126,507	0.0%
		NB			40,250	67,460	67.60%	-	68,383	69.90%	-		68,290	69.66%	-		68,593	70.42%	-		68,497	70.18%	-		67,458	67.60%	-	
		SB			40,889	67,535	65.17%	-	68,770	68.19%	-		68,561	67.68%	-		68,506	67.54%	-		68,545	67.64%	-		67,603	65.33%	-	
				Adj 2015 AAWDT	2015 AWDT Base Model Assigns	2040 AAWDT No-Build Assigns	% Growth 2015-40	2040 No-Build AAWDT	2040 AWDT Alt A Assigns	% Growth 2015-40	2040 Alt A AAWDT	AAWDT Difference Alt A vs No-Build	2040 AWDT Alt B Assigns	% Growth 2015-40	2040 Alt B AAWDT	AAWDT Difference Alt B vs No-Build	2040 AWDT Alt C Assigns	% Growth 2015-40	2040 Alt C AAWDT	AAWDT Difference Alt C vs No-Build	2040 AWDT Alt D Assigns	% Growth 2015-40	2040 Alt D AAWDT	AAWDT Difference Alt D vs No-Build	2040 AWDT Alt F Assigns	% Growth 2015-40	2040 Alt F AAWDT	AAWDT Difference Alt F vs No-Build

9.1.1 No-Build Conditions

A review of the table indicates that there is a reduction in trips on north-south roadways such as NH Route 28 Bypass, NH Route 28 and Fordway under No-Build conditions. This appears to be as a result of the additional capacity provided by the widening of I-93 to four lanes each way which allows through traffic to use the interstate for these north-south trips as opposed to the local roadways through Derry. Mainline volumes on I-93 increase by between 64-68% from 2015 and 2040, which is about a 2.5% annual growth rate. Volumes on the Exit 4 ramps increase between 95-125% from 2015 to 2040, while ramp volumes at Exit 5 only grow between 45-50% during the same period. This would appear to indicate the influence of the Woodmont Commons development in Londonderry on both sides of the Interstate being accessed from either side of Exit 4, and is also reflected in volume increase on NH Route 102 west of the interchange. Local roads in the Woodmont area, such as Gilcreast Road and Ash Street, also experience marked increases in traffic volumes under 2040 No-Build conditions.

9.1.2 Alternative A

Mainline volumes on I-93 show slightly higher growth rates under 2040 conditions with Exit 4A –Alternative A in place than in the No-Build condition. This is driven in part by Woodmont Commons because this development is assumed to reach its maximum potential with Alternative A in place, as opposed to either No-Build or most other Exit 4A options.

Exit 4 ramp volumes are affected to differing degrees with Alternative A in place. Growth rates for the NB on-ramp and SB off-ramp are about half what they are under the No-Build case, since this traffic is diverted to Exit 4A. The projected NB off-ramp volume of 17,385 vehicles per day (vpd), shows a 10% reduction over 2040 No-Build volumes. The development of Woodmont Commons to the west is reflected in the 10% increase in SB on-ramp volumes from the west side of the interchange, whereas the SB on-ramp volume from the east shows a 48% reduction in traffic that is now presumably using Exit 4A.

Exit 5 ramp volumes show greater increases on the NB off-ramp and SB on-ramp under Alternative A compared to the No-Build case. This would indicate increased interaction between Exit 4A and 5 to and from the north more than between Exits 4 and 4A, which is consistent with the findings in the previous DEIS for this project. (FHWA, 2007) The Exit 5 SB off-ramp actually shows a 43.5% reduction in traffic compared to No-Build, indicating that this traffic is likely continuing on the mainline down to Exit 4A. The NB on-ramp traffic volume is also about 20% lower than under No-Build conditions, indicating redistribution of some NB trips to Exit 4A and away from NH Route 28.

Exit 4A volumes range between 8,700-10,700 vehicles per day (vpd) on the NB off-ramp and SB on-ramp, and from 15,200 to 19,000 vpd on the NB on-ramp and SB off-ramp, respectively. The two northerly-oriented ramps have the higher volumes, consistent with the increased interaction between the new interchange and Exit 5. The projected volume on the connector road east of the Alternative A interchange is 53,700 vpd.

The local roadways are also affected by the introduction of a new interchange to the regional network. Volumes on NH Route 102 just east of Exit 4 are about half of the projected 2040 No-Build condition, while volumes closer to the downtown area show reductions of around 19%. Folsom Road shows significant increases, since it is now the primary connection between the new interchange and the local street network. Some of this increase continues easterly along the Tsienneto Road corridor (+3000 vpd over No-Build) and NH Route 102 east at the Chester town line (+1000 vpd over No-Build).

9.1.3 Alternative B

Mainline volumes on I-93 under this scenario show similar growth rates as Alternative A as compared to 2040 No-Build conditions. This is consistent with the earlier DEIS when comparing southerly versus northerly interchange locations.

Exit 4 ramp volumes show some differences as compared to Alternative A. Projected volumes on the NB on-ramp and SB off-ramp are slightly higher under Alternative B than A, but still 17-19% less than what they are under the No-Build case. This may be because Alternative B provides a section of new roadway onto the Derry street network, which may attract more traffic. The NB off-ramp shows a 10% volume reduction under Alternative B than under No-Build, similar to Alternative A. This development of Woodmont Commons to the west is reflected in an 8% increase in SB on-ramp volumes from the west side of the interchange, whereas the SB on-ramp volume from the east shows about a 44% reduction in projected traffic, similar to Alternative A.

Exit 5 ramp volumes show smaller increases on the NB off-ramp and SB on-ramp than under Alternative A. This continues to indicate the increased interaction between Exit 4A and 5 to and from the north more than between Exits 4 and 4A, which is consistent with the previous DEIS for this project. The Exit 5 SB off-ramp actually shows a greater reduction in traffic under Alternative B than under A, and this is reflected in a similarly higher volume at the Exit 4A SB off-ramp as compared to Alternative A. The Exit 5 NB on-ramp traffic is also lower than under No-Build conditions or Alternative A, indicating redistribution of some NB trips to Exit 4A and away from NH Route 28. These results appear to show that this alternative supports more of a north-south trip pattern than the east-west pattern exhibited under Alternative A.

Exit 4A volumes with Alternative B range between 9,500-12,400 vpd on the NB off-ramp and SB on-ramp, and from 13,200 to 19,400 vpd on the NB on-ramp and SB off-ramp, respectively. The SB on- and off-ramp volumes are higher than under Alternative A, but the NB on-ramp traffic is slightly lower than under Alternative A. The projected connector road volume east of the Alternative B interchange are about 54,500 vpd, and decrease to 16,200 vpd east of NH Route 28 along the Ashleigh Drive alignment.

The projected volumes on the local roadways under Alternative B have similar but generally slightly lower volumes than Alternative A. Volumes on NH Route 102 just east of Exit 4 are about 48% of the projected 2040 No-Build condition, while volumes closer to the downtown area show reductions around 19%. Folsom and Tsienneto Roads do not see the same increases as under Alternative A, since the new main connection road goes north of this area to intersect with Franklin Street Extension and Ashleigh Drive on the new alignment. The existing Tsienneto Road corridor sees minimal change since Alternative B creates a new roadway for the east-west traffic that currently uses this roadway to access the Interstate, but traffic volumes at the east end of the study area are higher than under Alternative A.

9.1.4 Alternative C

Mainline volumes on I-93 south of Exit 5 under this scenario show slightly higher growth rates than the southerly interchange alternatives (A and B) when compared to 2040 No-Build conditions. Projected volumes north of Exit 5 are consistent across all interchange alternatives, being slightly higher than No-Build.

Exit 4 ramp volumes under this alternative are slightly lower than the southerly interchange options, notably on the NB on-ramp and SB off-ramp, but higher for the SB on-ramp from the east than either Alternative A or B. This is likely indicative of the increased distance of the northerly interchange from the NH Route 102 corridor and the expectation of less effectiveness in reducing east-west traffic through the downtown area.

Impacts on Exit 5 ramp volumes show larger reductions in both the NB on-ramp and SB off-ramp volumes than the southerly interchange options. This makes sense, given the greater proximity of Alternatives C (and D) to Exit 5, which further emphasizes the increased interaction between Exit 4A and 5 to and from the north more than between Exits 4 and 4A, which is consistent with the previous DEIS for this project.

Exit 4A ramp volumes for trips to/from the south with Alternative C are noticeably lower than with the southerly interchange options, ranging between 2,800-5,000 vpd on the NB off-ramp and SB on-ramp. Trips on the NB on-ramp are similar to Alternative B but are lower on the SB off-ramp, respectively. The projected connector road volume east of the C interchange is less than under A or B (about 38,500 vpd), and decrease to 13,900 vpd west of NH Route 28 along the Ashleigh Drive alignment.

The projected volumes on the local roadways under Alternative C have similar but slightly larger volume reductions than Alternatives A or B. Volumes on NH Route 102 just east of Exit 4 are slightly lower than 2040 No-Build volumes but slightly higher than 2015 base conditions. Volumes further east on NH Route 102 show slightly larger reductions than under A or B. With the main connection road going north to NH Route 28 near the town line, volumes on this section of NH Route 28 more than double than under existing conditions. The existing Tsienneto Road corridor sees similar volume levels as Alternative B since C follows the new roadway to serve this east-west traffic demand.

9.1.5 Alternative D

Mainline volumes on I-93 under this scenario show similar growth rates as Alternative C as compared to 2040 No-Build conditions. This is consistent with the earlier DEIS where comparing southerly versus northerly interchange locations. Exits 4 and 5 ramp volumes under this option are also quite similar to Alternative C.

Exit 4A volumes with Alternative D are similar to Alternative C - the NB off-ramp and SB on-ramp volumes are lower than Alternative C but the SB off-ramp traffic is slightly higher. The projected connector road volume east of the Alternative D interchange is about 36,700 vpd.

The projected volumes on the local roadways under Alternative D have similarly but generally slightly lower reductions than Alternatives A or B. Volumes on NH Route 102 just east of Exit 4 are about the same as under 2015 base conditions, even if slightly lower than 2040 No-Build volumes. Volumes further east on NH Route 102 show smaller traffic reductions than any of the other interchange options. With the main connection road going north to NH Route 28 near the town line, volumes along this part of the NH Route 28 corridor more than double over existing conditions. The existing Tsienneto Road corridor also sees marked growth over existing volumes with this option since it follows the present roadway for east-west traffic.

9.1.6 Alternative F

Alternative F is essentially the Transportation Systems Management (TSM) option, which from the traffic model’s perspective is essentially a third lane along NH Route 102 to provide some additional capacity at intersections east of Exit 4 into downtown Derry.

Mainline volumes on I-93 under this scenario show similar growth rates compared to 2040 No-Build conditions and lower than with an interchange alternative. This is consistent with the lower growth scenario as compared to those with a new interchange. Exits 4 and 5 ramp volumes under this option are also quite similar to 2040 No-Build conditions. With the provision of some additional capacity along the existing NH Route 102 corridor easterly into downtown Derry, traffic volumes are higher than under No-Build conditions or with any of the interchange alternatives, so it does not meet the Purpose and Need for the project.

Figures 8 through 12 graphically show these volume comparisons by alternative for key areas of interest as part of this study: the Exit 4 ramps, Exit 5 ramps, Exit 4A ramps, points along the NH Route 102 corridor, and other local streets of interest, respectively.

9.2 Composition of Through Traffic in Downtown Derry

While the volume reductions may not be as profound on the surface as one might expect, it is the composition of the trips in the downtown area that are of interest, since one of the Purposes and Needs of the project is to reduce through traffic in downtown Derry that had neither an origin nor destination there. Existing travel patterns suggest that a good deal of existing traffic is already finding alternative routes to avoid the downtown area.

To test the sensitivity of the hypothesis of a reduction in ‘through’ traffic as a result of a new interchange, a link on NH Route 102 just west of the main downtown area, which is the location east of Griffin Street near the Beaver Brook bridge, was chosen as a representative location of downtown traffic. The SNHPC model can generate trip tables that will provide the origin and destination zone for trips on any link in the network in either direction. This traffic pattern was evaluated by comparing the number of trips from zones and external stations from the east and northeast that are currently assigned to that link under existing (2015) base, 2040 No-Build and 2040 –Alternative A conditions, which was the Preferred Alternative in the previous DEIS for this project, that might be diverted to another route/path under any Build scenario.

A series of TAZs from the SNHPC traffic model area to the east and northeast were aggregated to see how many trips remained on this link under the different scenarios, as shown in Figures 13 and 14. The ones of primary interest were noted as follows:

- North Derry – TAZs 121-124, 126, 127
- East Derry – TAZs 128-130, 145-147, 221, 225
- Chester – TAZs 148-155
- Raymond/Deerfield/Candia – TAZs 156-191
- External Stations east and northeast – Stations 308-324

Table 8 shows a summary of the assigned trips to this link in each direction as well as combined under the three scenarios. In summary, the table shows that, in general, the trips to and from these zones to the east that now pass through the downtown area are lower with an interchange alternative (in this case, Alternative A) in place than under the 2040 No-Build scenario. However, since the overall link volume is reduced as well, these trips make up a slightly higher percentage of the total trips on that link than under No-Build conditions. This appears logical, because this link is likely the shortest path from these easterly zones to destinations in downtown Derry. Nevertheless, this analysis appears to show that an interchange alternative will reduce the amount of through traffic in downtown Derry for trips to and from the east and northeast.

TABLE 8

SELECT LINK ANALYSIS

NH ROUTE 102, EAST OF GRIFFIN ROAD, DERRY, NH

Eastbound (To)	N Derry	E Derry	Chester	Raymond/Candia/ Deerfield	N/NE/SE External Stations				
Traffic Zones	121-124. 126,127	128-130, 145-147, 221, 225	148-155	156-191	308-324	Target zone total	Increase over 2015 Base	Total trips on link	% of total to target zones
2015 Base	1194	642	162	293	1209	3500		8,806	39.7%
% total on link	13.6%	7.3%	1.8%	3.3%	13.7%				
2040 No-Build	1332	1056	130	78	1282	3878	1.1%	9,642	40.2%
% total on link	13.8%	11.0%	1.3%	0.8%	13.3%				
2040 Alt A	571	1235	236	146	1845	4033	1.2%	9,108	44.3%
% total on link	6.3%	13.6%	2.6%	1.6%	20.3%				
Westbound (From)	N Derry	E Derry	Chester	Raymond/Candia/ Deerfield	N/NE/SE External Stations				
Traffic Zones	121-124. 126,127	128-130, 145-147, 221, 225	148-155	156-191	308-324	Target zone total	Increase over 2015 Base	Total trips on link	% of total to target zones
2015 Base	1177	814	114	192	760	3057		9,191	33.3%
% total on link	12.8%	8.9%	1.2%	2.1%	8.3%				
2040 No-Build	1663	1465	64	37	773	4002	1.1%	11,168	35.8%
% total on link	14.9%	13.1%	0.6%	0.3%	6.9%				
2040 Alt A	307	1097	156	113	1073	2746	0.8%	7,776	35.3%
% total on link	3.9%	14.1%	2.0%	1.5%	13.8%				
Both Directions	N Derry	E Derry	Chester	Raymond/Candia/ Deerfield	N/NE/SE External Stations				
Traffic Zones	121-124. 126,127	128-130, 145-147, 221, 225	148-155	156-191	308-324	Target zone total	Increase over 2015 Base	Total trips on link	% of total to target zones
2015 Base	2371	1456	276	485	1969	6557		18,002	36.4%
% total on link	13.2%	8.1%	1.5%	2.7%	10.9%				
2040 No-Build	2995	2521	194	115	2055	7880	2.3%	20,810	37.9%
% total on link	14.4%	12.1%	0.9%	0.6%	9.9%				
2040 Alt A	878	2332	392	259	2918	6779	1.9%	16,885	40.1%
% total on link	5.2%	13.8%	2.3%	1.5%	17.3%				

9.3 Comparison to I-93 SEIS 2030 Mainline Projections

An additional comparison was made to the projected 2030 mainline volumes on I-93 as shown in the SEIS for the I-93 project (NHDOT, 2009). This document utilized the statewide traffic model that was available at the time, and also included the proposed Exit 4A Preferred Alternative as part of the network.

However, there are some major differences between the two scenarios. First, there are two different design years: the I-93 SEIS went out only to 2030 while this Exit 4A SDEIS extends out to 2040, so there are ten more years of overall growth that contributes additional traffic onto the network. Secondly, the I-93 SEIS did not account for the full Woodmont Commons development scenario included in the Exit 4A project for the Preferred Alternative, which adds a substantial number of trips to the area in and around Exit 4 and the proposed Exit 4A. Given these factors, it is expected that design hourly volumes would be higher under the 2040 case.

Table 9 shows excerpts from Tables 4-12 and 4-13 from the 2009 I-93 SEIS, which includes the projected ADT and DDHV for 2020 and 2030 from that document. The current table includes a projection of these volumes to 2040 using the same growth rates, including Exit 4A which was included in the I-93 SEIS Build condition, and the projected AAWDT and DDHV from the latest SNHPC modeling to the 2040 design year, and a comparison between the two modelling efforts.

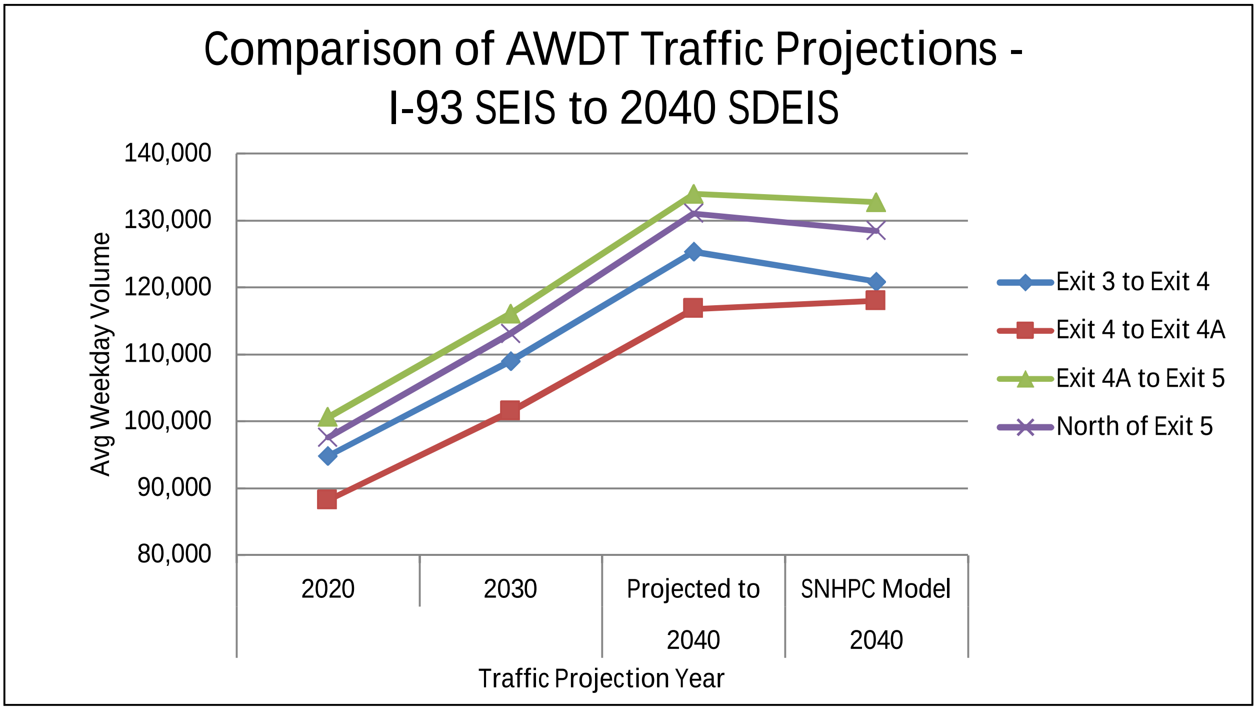
These comparisons show that the more recent SNHPC AAWDT traffic projections are consistent with the growth trend line from the I-93 SEIS if it were extended to the same 2040 design year within less than 4%. Similarly, the differences calculated DDHV extended to 2040 are within 3% when using the same methodology. The last two points on the graphs compare the 2040 projections for both the I-93 numbers and the latest SNHPC projections. Therefore, it would appear that the two modelling efforts are reasonably close to each other when extending the original I-93 design horizon out to 2040.

The original I-93 SEIS also noted that the congested flow capacity for I-93 would be 1,800 vph per lane, which would be 7,200 vph for the projected four-lane Interstate project. Should this volume be exceeded, the volumes would have to be adjusted to account for the effect of peak spreading that would likely occur into the adjacent hours before and after this demand was projected. At first glance, it appears that this scenario may also occur between Exits 4A and 5 and north of Exit 5 when using the SNHPC 2040 model projections, using the same DDHV calculation assumptions as in the I-93 SEIS. However, a more detailed review of the projected 2040 mainline volumes, which are discussed below, indicates that this 7,200 vph threshold will not likely be reached under any Exit 4A scenario.

TABLE 9
COMPARISON OF I-93 SEIS AND EXIT 4A SDEIS TRAFFIC PROJECTIONS
2020, 2030 AND 2040 DESIGN YEARS, INCLUDING EXIT 4A

Average Annual Weekday Traffic (AAWDT) Projections

	I-93 SEIS				SNHPC 2040	
I-93 Segment	2020 Build	2030 Build	Growth Rate/Year	Projected To 2040	Model Projections Alternative A	% Difference
Exit 3 to Exit 4	94,800	109,000	1.014	125,330	120,860	-3.6%
Exit 4 to Exit 4A	88,200	101,500	1.014	116,810	118,015	1.0%
Exit 4A to Exit 5	100,600	116,100	1.014	133,990	132,734	-0.9%
North of Exit 5	97,600	113,100	1.015	131,060	128,466	-2.0%



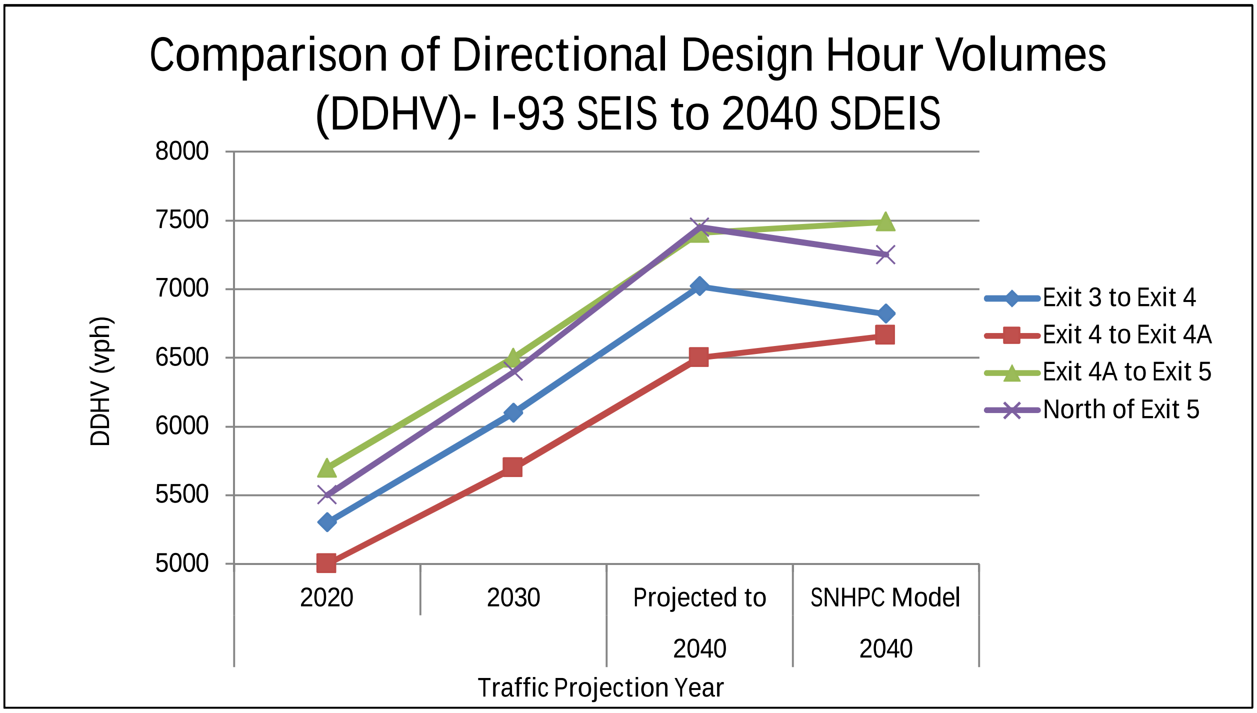
Notes:
DDHV calculated as 9.4% of ADT with a 60/40 directional split, consistent with I-93 SEIS, using Scenario 2 (OEP Projections)

Source: NHDOT, Supplemental Environmental Impact Statement and Reevaluation/Section4(f) Evaluation, August 2009, Tables 4-12 and 4-13

TABLE 9 (Cont'd)
COMPARISON OF I-93 SEIS AND EXIT 4A SDEIS TRAFFIC PROJECTIONS
2020, 2030 AND 2040 DESIGN YEARS, INCLUDING EXIT 4A

Directional Design Hourly Volume (DDHV) Projections

	I-93 SEIS				SNHPC 2040	
I-93 Segment	2020 Build	2030 Build	Growth Rate/Year	Projected To 2040	Calculated DDHV Alternative A	% Difference
Exit 3 to Exit 4	5,300	6,100	1.014	7,020	6,820	-2.8%
Exit 4 to Exit 4A	5,000	5,700	1.013	6,500	6,660	2.5%
Exit 4A to Exit 5	5,700	6,500	1.013	7,410	7,490	1.1%
North of Exit 5	5,500	6,400	1.015	7,450	7,250	-2.7%



Notes:
DDHV calculated as 9.4% of ADT with a 60/40 directional split, consistent with I-93 SEIS, using Scenario 2 (OEP Projections)

Source: NHDOT, Supplemental Environmental Impact Statement and Reevaluation/Section4(f) Evaluation, August 2009, Tables 4-12 and 4-13

10.0 Derivation of 2040 Volumes for Analysis Purposes

Now that the projected 2040 AAWDT volumes have been provided by the SNHPC model and appear to be reasonable, these need to be reduced to AM and PM peak volumes for analysis purposes. Since the SNHPC model provides only daily volumes, these must be reduced to peak hours on both the I-93 mainline and interchange ramp terminals as well as at the various study area intersections that may be directly or indirectly affected by any alternative. Different procedures were used to develop these volumes to be used for analysis purposes.

As noted earlier, the full development potential of Woodmont Commons was assigned to the study area traffic model network as a worse-case scenario, but if much of the site-generated traffic is captured internally to the site - as is the design intent of this mixed-use development - operations would be better than projected and the design life of any roadway and intersection improvements would be extended.

10.1 Mainline Interstate Volumes

A different procedure was used to generate the 2040 No-Build interstate networks as was done for deriving the 2015 base network for calibration. The projected 2040 AAWDT was calculated based on the projected growth (positive or negative) reflected in the model assignments on that segment between 2015 and 2040, then this growth rate was applied to the adjusted 2015 AAWDT. Then, the 2040 projected AM and PM peak hour volumes were derived based on the percentage that the existing (2015) AM and/or PM peak hour volume was as a percentage of the adjusted 2015 AAWDT, since these percentages should not change substantially over time. These peak hour percentages generally fell in the range of 6-9% of AAWDT. Tables J-1 through J-6 in Appendix J show summary tables of the projected 2040 peak hour volumes for each alternative on the key links on the interstate and local roadway networks.

As in the 2015 base case, the most logical starting point for developing the balanced interstate networks is south of Exit 4, where NHDOT permanent recorder data should provide more reliability. The various interchange ramp volumes were then taken directly from the appropriate tables in Appendix J, and the mainline volumes were balanced through the network to the point north of Exit 5. This process was followed to develop 2040 AM and PM peak hour volumes along the Interstate for each alternative, which are shown graphically in Figures 15 through 26.

10.2 Local Intersection Volumes

A more detailed procedure was needed to derive peak hour intersection volumes for each alternative from the regional traffic model to be used for design purposes. Since the SNHPC model only provides daily volumes, a relationship needs to be established between the peak hour volumes from the actual turning movement count at any intersection and the model output that can be made available. The SNHPC model can provide daily volumes between any two nodes through one central node that would simulate movements at an intersection. As such, information was requested from SNHPC for the daily model assignments for each study area intersection for each alternative to assist in developing turning movements at each location. Then a procedure was developed to estimate intersection turning movements at each study area location based on the existing turning movement volumes for both the AM and PM peak hours and how the total and individual turn volumes change as a result of the reassignment of traffic under any scenario. This process had to be usable regardless of alternative or the magnitude of change in traffic assignments for any movement at a specific intersection from one alternative to another. The procedure is discussed in greater detail in the memorandum dated September 29, 2017, which is attached in Appendix K. **The memo was reviewed and approved by the NHDOT before the procedure was applied to the rest of the alternatives (NHDOT, 2017c).**

The resulting AM and PM peak hour volumes for each study area intersection for each of the 2040 alternatives are provided in Figures 27 through 38.

11.0 Analysis of Interstate Operations

As in the existing case, the Freeway Facilities procedure from the *2010 HCM* and replicated in the HCS was used to evaluate the mainline interstate operations under all 2040 conditions. A free flow speed of 70 mph and a Peak Hour Factor of 0.94 were agreed upon by NHDOT (NHDOT, 2017d) to be used in the HCM analysis. With the introduction of a northerly or southerly interchanges, certain design parameters consistent with the I-93 layout were agreed upon with the NHDOT to ensure that the appropriate distances would be used in the analyses. A conceptual layout for the southerly interchange for Alternatives A and B had already been provided in the 2007 DEIS as well as part of the I-93 design between Exits 4 and 5, and was used to determine ramps spacing for analysis purposes. The previous conceptual layout for the northerly interchange for Alternatives C and D from the 2007 DEIS was used as the starting point for this study.

The HCM procedure accounts for a 1,500 foot ‘influence area’ in the ramp merge or diverge areas. With the southerly interchange, there is overlap between the influence areas of the Exit 4 NB on-ramp and the Exit 4A NB off-ramp, as well as the Exit 4A SB on-ramp and the Exit 4 SB off-ramp. As such, the HCS analysis software allows for this overlap to be considered, and is reflected in the results.

The Freeway Facilities criteria in the HCS were provided in Appendix E when the 2015 operations were discussed for the existing two-lane facility. The 2040 results for the proposed four-lane facility are summarized in Table 10 with the HCM printouts provided in Appendix L. By definition, if the demand/ capacity (d/c) ratio is greater than 1.00, ramp merge/diverge or mainline operations will be constrained, either by traffic unable to merge onto the interstate and subsequently affecting ‘topside’ operations at the ramp terminals, or by the off-ramp being unable to process the demand for exiting traffic, which may affect mainline traffic free flow speeds.

The 2040 cases where d/c ratios are 0.98 or greater, indicating potential capacity constraints to I-93 operations with a single-lane ramp, are noted below:

- Alternative A – Exit 4A SB off-ramp diverge – AM peak
- Alternative B – Exit 4A SB off-ramp diverge – AM peak
- Alternative B – Exit 4 NB on-ramp merge – AM peak
- Alternative B – Exit 4 SB off-ramp diverge – PM peak
- Alternative F – Exit 4 NB on-ramp merge – AM and PM peaks
- Alternative F – Exit 4 SB off-ramp diverge – PM peak

These results appear to reflect the increased demands from the higher development scenarios from the Woodmont Commons development under Alternatives A and B, as well as the projected limitations at the Exit 4 interchange with Alternative F in place, even with a lesser development scenario for Woodmont Commons.

If the projected Exit 4 NB on-ramp volumes reach levels where the merge with the mainline I-93 is affected as shown, it would likely result in backups of traffic back to the ramp terminal itself, affecting the topside intersections along NH Route 102. Both the Exit 4 and Exit 4A SB off-ramp diverge constraints could be ameliorated by providing a two-lane off-ramp to service the projected traffic should actual volumes meet projections in the future.

However, given the aforementioned discussion about the possible realization of the Woodmont Commons internal capture rate and the subsequent reduction in traffic assignments onto the study area network, a sensitivity analysis was conducted at the Exit 4A SB off-ramp to determine what kind of volume reduction would be needed to provide an acceptable LOS for a single-lane off-ramp at this location. If the projected off-ramp AM peak volume was reduced by only 200 vph, this ramp would function at a LOS D with a demand/capacity ratio of 0.94, which would be acceptable. Therefore, should the full impact of the traffic projections from Woodmont Commons or the overall study area development scenario not be realized, the ramps that are projected to be capacity-constrained may operate better than these analyses would indicate.

19-Jun-17

rev 4-12-18

TABLE 10

HCS 2010 - FREEWAY FACILITIES ANALYSIS - 2040 NO-BUILD AND BUILD (South Interchange) CASES - AM and PM PEAK HOURS

		2040 No Build						4A Alternative A						4A Alternative B					
		AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)			AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)			AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)		
Segment	Northbound Direction	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE
1	I-93 Mainline south of Exit 4	B/0.37			C/0.63			B/0.38			C/0.66			B/0.38			C/0.66		
2	Exit 4 NB off-ramp		A/0.26			B/0.61			A/0.23			B/0.67			A/0.23			B/0.67	
3	I-93 Mainline between Exit 4 ramps	A/0.28			B/0.37			A/0.30			B/0.42			A/0.30			B/0.42		
4	Exit 4 NB on-ramp			C/1.25			C/0.99			B/0.89			C/0.70			C/1.03			C/0.81
5	I-93 Mainline between Exit 4 on-ramp and Exit 4A off-ramp							B/0.49			C/0.56			C/0.52			C/0.59		
6	Exit 4A NB off-ramp				N/A				C/0.48			C/0.41			C/0.52			C/0.44	
7	I-93 Mainline between Exit 4A ramps							B/0.40			B/0.48			B/0.43			B/0.50		
8	Exit 4A NB on-ramp									C/0.84			C/0.72			C/0.73			C/0.48
9	I-93 Mainline between Exit 4(4A) NB on- and Exit 5 NB off-ramps	B/0.55			C/0.57			C/0.56			C/0.62			C/0.56			C/0.62		
10	Exit 5 NB off-ramp		C/0.37			C/0.49			C/0.43			D/0.58			C/0.41			D/0.54	
11	I-93 Mainline between Exit 5 ramps	B/0.48			B/0.49			B/0.49			C/0.53			B/0.49			C/0.54		
12	Exit 5 NB on-ramp			C/0.83			C/0.62			C/0.67			C/0.50			C/0.65			C/0.48
13	I-93 Mainline north of Exit 5	C/0.64			C/0.62			C/0.62			C/0.65			C/0.62			C/0.65		
	Facility operations	B			C			B			C			B			C		
	Space Mean Speed (mph)	68.4			68.6			68.5			67.9			67.6			67.9		
	Density (veh/mi/hr)	15.8			19.2			16.4			20.2			17.3			20.4		
Segment	Southbound Direction																		
1	I-93 Mainline north of Exit 6	C/0.59			C/0.64			C/0.62			C/0.62			C/063			C/0.62		
2	Exit 5 SB off-ramp		D/0.73			D/0.74			C/0.41			C/0.62			C/0.32			C/033	
3	I-93 Mainline between Exit 5 ramps	B/0.46			B/0.49			C/0.55			C/0.53			C/0.57			C/0.55		
4	Exit 5 SB on-ramp			C/0.45			C/0.38			C/0.52			B/0.44			B/0.40			B/0.34
5	I-93 Mainline between Exit 5 SB on- and Exit 4A SB off-ramps							C/0.65			C/0.61			C/0.65			C/0.62		
6	Exit 4A SB off-ramp				N/A				C/0.94			D/0.89			C/0.94			D/0.91	
7	I-93 Mainline between Exit 4A ramps							B/0.46			B/0.44			B/0.45			B/0.44		
8	Exit 4A SB on-ramp									B/0.60			C/0.51			C/0.70			C/0.58
9	I-93 Mainline between Exit 5(4A) SB on- and Exit 4 SB off-ramps	C/0.55			C/0.56			D/0.57			D/0.54			D/0.58			D/055		
10	Exit 4 SB off-ramp		C/0.84			D/1.10			D/0.76*			C/0.91			C/0.81			D/0.98	
11	I-93 Mainline between Exit 4 SB off- and SB on ramp from east	B/0.36			B/0.33			B/0.43			B/0.36			B/0.43			B/0.36		
12	Exit 4 SB on-ramp from east			B/0.66			B/0.30			B/0.49			A/0.16			B/0.37			A/0.17
13	I-93 Mainline between Exit 4 SB on-ramps	B/0.48			B/0.38			B/0.49			B/0.39			B/0.49			B/0.39		
14	Exit 4 SB on-ramp from west			C/0.85		B/0.40				C/0.93			B/0.44			C/0.92		B/0.43	
15	I-93 Mainline south of Exit 5	C/0.64			B/0.46			C/0.66			B/0.47			C/0.66			B/0.47		
	Facility operations	C			C			C			C			C			C		
	Space Mean Speed (mph)	68.5			68.3			67.4			68.6			67.3			68.4		
	Density (veh/mi/hr)	18.8			19.1			20.6			18.4			20.9			18.9		

* = 2-lane off-ramp assumed

19-Jun-17
rev 4-12-18

TABLE 10 (cont.)

HCS 2010 - FREEWAY FACILITIES ANALYSIS - 2040 NO-BUILD AND BUILD (North or No Interchange) CASES - AM and PM PEAK HOURS

Segment	Northbound Direction	2040 No Build						4A Alternative C						4A Alternative D						4A Alternative F					
		AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)			AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)			AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)			AM Peak Hour (LOS) / (d/c ratio)			PM Peak Hour (LOS) / (d/c ratio)		
		BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE	BASIC	DIVERGE	MERGE
1	I-93 Mainline south of Exit 4	B/0.37			C/0.63			B/0.37			C/0.64			B/0.37			C/0.64			B/037			C/0.64		
2	Exit 4 NB off-ramp		A/0.26			B/0.61			A/0.24			B/0.56			A/0.25			B/0.59			A/0.26			B/0.62	
3	I-93 Mainline between Exit 4 ramps	A/0.28			B/0.37			A/0.28			B/0.39			A/0.28			B/0.38			A/0.28			B/0.37		
4	Exit 4 NB on-ramp			C/1.25			C/0.99			B/0.93			B/0.73			B/0.90			B/0.71			C/1.25			C/0.99
5	I-93 Mainline between Exit 4 on-ramp and Exit 4A off-ramp	N/A						B/0.49			C/0.54			B/0.48			B/0.52			B/0.55			C/0.57		
6	Exit 4A NB off-ramp	N/A							B/0.15			C/0.13			B/0.08			B/0.07							
7	I-93 Mainline between Exit 4A ramps	N/A						B/0.46			B/0.51			B/0.46			B/0.51								
8	Exit 4A NB on-ramp	N/A								C/0.74			C/0.63			C/0.76			C/0.64						
9	I-93 Mainline between Exit 4 (4A) NB on- and Exit 5 NB off-ramps	B/0.55			C/0.57			C/0.60			C/0.64			C/0.60			C/0.64								
10	Exit 5 NB off-ramp		C/0.37			C/0.49			C/0.40			C/0.51			C/0.41			D/0.55			C/0.36			C/0.48	
11	I-93 Mainline between Exit 5 ramps	B/0.48			B/0.49			C/0.53			C/0.56			C/0.53			C/0.55			B/0.49			B/0.49		
12	Exit 5 NB on-ramp			C/0.83			C/0.62			C/0.48			C/0.36			C/0.49			C/0.39			C/0.82			C/0.62
13	I-93 Mainline north of Exit 5	C/0.64			C/0.62			C/0.63			C/0.63			C/0.63			C/0.63			C/0.65			C/0.62		
	Facility operations	B			C			B			C			B			C			B			C		
	Space Mean Speed (mph)	68.4			68.6			68.4			68.3			68.6			68.4			68.4			68.6		
	Density (veh/mi/hr)	15.8			19.2			16.4			19.7			16.4			19.5			15.8			19.2		

Segment	Southbound Direction	2040 No Build						4A Alternative C						4A Alternative D						4A Alternative F					
		AM BASIC	AM DIVERGE	AM MERGE	PM BASIC	PM DIVERGE	PM MERGE	AM BASIC	AM DIVERGE	AM MERGE	PM BASIC	PM DIVERGE	PM MERGE	AM BASIC	AM DIVERGE	AM MERGE	PM BASIC	PM DIVERGE	PM MERGE	AM BASIC	AM DIVERGE	AM MERGE	PM BASIC	PM DIVERGE	PM MERGE
1	I-93 Mainline north of Exit 6	C/0.59			C/0.64			C/0.62			C/0.61			C/0.62			C/0.61			C/0.58			C/0.64		
2	Exit 5 SB off-ramp		D/0.73			D/0.74			C/0.31			C/0.31			C/0.31			C/0.32			C/0.66			C/0.67	
3	I-93 Mainline between Exit 5 ramps	B/0.46			B/0.49			C/0.57			C/0.55			C/0.57			C/0.55			B/0.47			B/0.50		
4	Exit 5 SB on-ramp			C/0.45			C/0.38			C/0.45			C/0.38			C/0.44			C/0.38			B/0.45			B/0.38
5	I-93 Mainline between Exit 5 SB on- and Exit 4A SB off-ramps	N/A						C/0.66			C/0.63			C/0.66			C/0.62			C/0.55			C/0.57		
6	Exit 4A SB off-ramp	N/A							D/0.92			D/0.79			D/0.91			D/0.78		N/A					
7	I-93 Mainline between Exit 4A ramps	N/A						B/0.48			B/0.46			B/0.48			B/0.46			N/A					
8	Exit 4A SB on-ramp	N/A								B/0.27			B/0.23			B/0.25			B/0.21	N/A					
9	I-93 Mainline between Exit 5(4A) SB on- and Exit 4 SB off-ramps	C/0.55			C/0.56			B/0.52			B/0.51			B/0.52			B/0.50			N/A					
10	Exit 4 SB off-ramp		C/0.84			D/1.10			C/0.64			C/0.76			C/0.63			C/0.75			C/0.85			D/1.12	
11	I-93 Mainline between Exit 4 SB off- and SB on ramp from east	B/0.36			B/0.33			B/0.40			B/0.34			B/0.40			B/0.34			B/0.36			B/0.33		
12	Exit 4 SB on-ramp from east			B/0.66			B/0.30			B/0.46			B/0.21			B/0.46			B/0.21			B/0.67			B/0.30
13	I-93 Mainline between Exit 4 SB on-ramps	B/0.48			B/0.38			C/0.48			B/0.38			B/0.48			B/0.38			B/0.48			B/0.38		
14	Exit 4 SB on-ramp from west			C/0.85		B/0.40				C/0.86			B/0.40			C/0.85			B/0.40			C/0.84			B/0.39
15	I-93 Mainline south of Exit 5	C/0.64			B/0.46			C/0.64			B/0.46			C/0.64			B/0.46			C/0.64			B/0.46		
	Facility operations	C			C			C			C			C			C			C			B		
	Space Mean Speed (mph)	68.5			68.3			67.9			68.5			67.9			68.6			68.5			68.4		
	Density (veh/mi/hr)	18.8			19.1			19.9			17.8			19.8			17.8			18.8			19.1		

12.0 Estimated Contribution of Woodmont Commons Traffic to Interstate Ramp Volumes

During the review of the traffic projections, the NHDOT inquired as to the potential impact that traffic from the Woodmont Commons development may have on the Exit 4 ramps under the various alternatives, since the southerly interchange alternatives (A and B) assume a higher intensity of development that under all other alternatives, including the No-Build.

As noted earlier, the 2040 projections from the SNHPC regional traffic model do not account for the same level of 'internally captured' trips within the development itself in the traffic assignments used for the Exit 4A project, as opposed to the site-specific traffic study prepared for the Woodmont project that assumed as much as a 23% internal captured trip rate in their projections and traffic assignments (TEC, 2013). Nevertheless, the model assignments should be able to present an 'order of magnitude' assessment of the relative contribution of traffic to the Exit 4 and 4A ramps from the three traffic analysis zones that Woodmont Commons would eventually occupy.

To accomplish this, SNHPC was tasked with providing 'select link' assignments to the Exit 4 and 4A ramps for trips from the three Woodmont Common zones (Zone 277 to the west, and Zones 69 and 375 to the east) under different scenarios: 2015 No-Build; 2040 No-Build; and 2040 Build with either Alternative A (southern interchange) and Alternative C (northern interchange). This information was summarized in a technical memo provided to the NHDOT for their review and concurrence (CLD, 2018), which is attached in Appendix M.

The results show that under the 2015 No-Build case, the three Woodmont zones only account for about 13% of the total traffic volume on all Exit 4 ramps, almost exclusively from the existing development in Zone 277 on the west side of I-93 in the Garden Lane area. Under the 2040 No-Build condition, the total volumes on the Exit 4 ramps would more than double, even with a lesser Woodmont development scenario, and these three zones now comprise almost 27% of this total Exit 4 ramp traffic and almost 40% of the projected increase in traffic.

With Exit 4A in place under Alternative A, which also assumes the most intense Woodmont development scenario, traffic assignments from the three subject zones account for 36% of the total Exit 4 ramp volume, most of which comes from Zone 277 on the west side. At Exit 4A, the two easterly Woodmont zones also account for 36% of total Exit 4A ramp traffic with no traffic assigned to these ramps from the west side.

With Alternative C in place, which assumes the same development scenario for Woodmont as in the 2040 No-Build case, the total traffic on the Exit 4 ramps is roughly the same as under Alternative A, but the Woodmont contribution is a slightly lower percentage (32%) of the total. At Exit 4A, Woodmont traffic would comprise only about 1% of the total ramp assignments, given that it is further removed from the traffic zones in question.

This analysis is only intended to show the relative potential contribution of Woodmont Commons traffic to both Exits 4 and 4A based on the full assignment of this traffic to the network as reflected in the SNHPC regional traffic model. As the Woodmont Commons development progresses and traffic is added to the adjacent road network, this situation should be monitored to determine how the actual additional traffic impacts affect overall traffic operations. Should the magnitude of the ‘internal capture’ trip rate be closer to what the TEC study anticipated, operations on the ramps, their intersections with the local road system, and the overall Interstate system would be better than by using the more conservative SNHPC model projections.

13.0 Exit 4A and Connecting Roadways

The Exit 4A interchange is currently proposed as a diamond configuration with access only to and from the east. As such, it creates two new ramp terminal intersections that will be provided with sufficient lanes to operate at an acceptable LOS. The connector road to the existing roadway network was assumed to be a four-lane limited access arterial roadway between the interchange and NH Route 28 to the east, with future breaks in access reserved for the proposed Woodmont Commons-East parcel based on their future development layout. New intersections would be created under all Build alternatives and existing intersections that would be affected by each of the respective layouts would need to be upgraded, which will be discussed in the next section.

The following is a listing of new intersections created by the connector roadway under the various interchange alternatives:

- Alternative A – Connector Road with North High Street.
- Alternative B – Connector Road with Franklin Street Extension, NH Route 28 Bypass, and relocated Tsienneto Road. In addition, the existing intersection with Ashleigh Drive will be reconfigured.
- Alternative C– Connector Road with NH Route 28 near the Londonderry town line, as well as NH Route 28 Bypass and relocated Tsienneto Road.
- Alternative D – Connector Road with NH Route 28 near Londonderry town line.

14.0 Analysis of Local Intersection Operations

Only those known programmed projects in the SNHPC 2040 Long-Range Transportation Plan (SNHPC, 2017) were included as foreseeable projects in the traffic modeling for this study. However, it is also assumed that ongoing State and Town traffic maintenance projects, such as signal retiming and optimization, will occur during the duration of the design horizon. Therefore, any intersection analyses assumes the optimization of signal timing and phasing at a specific location as a base condition, with any additional lane improvements evaluated as an impact associated with a specific alternative.

In addition, the Woodmont Commons development has also developed conceptual plans along the NH Route 102 corridor, as well as other intersections in Londonderry and Derry, to accommodate their projected traffic as that project moves forward (TEC, 2013). **The NHDOT has agreed that these projects should be considered as part of the 2040**

No-Build condition (NHDOT, 2016f). While most of these future improvements on NH Route 102 are west of Exit 4, including the Garden Lane and Gilcreast Road intersections, there are other improvements in the Exit 4A study area east of I-93 that will be considered as part of this No-Build condition for analysis purposes. These include:

- # 5 - NH Route 102/Londonderry Road intersection – signalization and lane additions, including a second east-west through lane on NH Route 102.
- # 8- North High Street/Ash Street Extension – providing a four-way stop controlled intersection, as well as separate left- and right-turn lanes exiting Ash Street, and adding an exclusive SB right-turn lane from North High Street onto Ash Street Extension.

It also should be noted that not all of the study area intersections are directly affected by the Exit 4A alternatives, even though the redistribution of traffic will have an indirect effect. Only those intersections that a specific alternative passes through were considered for any additional improvements as part of the project to maintain an acceptable LOS D or better for the overall intersection as well as on any individual approach. Analyses were conducted for all of the study area intersections, either with or without any required improvements.

It was also assumed that signalization would be required at many of the existing unsignalized locations where an alternative passes through it or where new intersections were being created at major State or local roadways. No formal signal warrants study was performed, but engineering judgment was applied to treat each of these locations the same if they were part of the layout of an alternative. Conversely, if the alternative did not go through that location, the existing traffic control was assumed to remain in place, regardless of operational efficiency, since these locations have not yet been programmed for further improvements.

15. Signalized Intersections

A summary table for the comparison of lane use and operations at each existing or proposed signalized intersection is provided in Table 11. No additional improvements to the lane use at the Exits 4 and 5 ramp terminals were investigated as part of any Build alternative, since these are being reconstructed as part of the ongoing I-93 project. The results are provided using the HCM 2000 procedures, since these procedures can address many non-standard timing and phasing parameters that later versions of the HCM cannot, as well as to be consistent with the Interstate Justification Report being conducted separately. (Louis Berger, 2018). The actual HCM and Synchro printouts for all the 2040 alternatives are provided in Appendices N through S.

Table 11
Summary of 2040 Capacity Analyses by Alternative

Signalized Intersections

Intersection	2040 Alternative	AM Peak Hour			PM Peak Hour			Comments/ Lane Use Revisions
		v/c ratio	Average Delay	LOS	v/c ratio	Average Delay	LOS	
#1 - Exit 4 SB Off Ramp/NH 102	No-Build	1.08	44.5	D	1.22	106.4	f	Current lane use per I93 project
	Alternative A	0.92	25.9	C	1.09	50.9	D	Current lane use per I93 project
	Alternative B	0.93	26.8	C	1.09	53.9	D	Current lane use per I93 project
	Alternative C	1.00	36.1	D	1.09	57.2	E	Current lane use per I93 project
	Alternative D	0.99	35.1	D	1.11	59.6	E	Current lane use per I93 project
	Alternative F	1.09	51.0	D	1.14	61.5	E	Current lane use per I93 project
#2 - Exit 4 NB Off Ramp/NH 102	No-Build	1.10	61.4	E	1.12	92.8	F	Current lane use per I93 project
	Alternative A	1.04	71.2	E	1.11	115.1	F	Current lane use per I93 project
	Alternative B	0.99	54.8	D	1.06	88.0	F	Current lane use per I93 project
	Alternative C	1.02	62.1	E	1.05	82.0	F	Current lane use per I93 project
	Alternative D	1.04	67.3	E	1.06	81.8	F	Current lane use per I93 project
	Alternative F	1.06	57.5	E	1.15	91.8	F	Current lane use per I93 project
#3 - Exit 5 SB Off Ramp/NH 28	No-Build	1.17	77.0	E	0.90	31.2	C	Current lane use per I93 project
	Alternative A	1.06	49.3	D	0.83	20.1	C	Current lane use per I93 project
	Alternative B	0.86	28.0	C	0.70	16.9	B	Current lane use per I93 project
	Alternative C	0.83	22.9	C	0.62	15.0	B	Current lane use per I93 project
	Alternative D	0.82	23.3	C	0.61	15.2	B	Current lane use per I93 project
	Alternative F	1.10	62.1	E	0.87	27.8	C	Current lane use per I93 project
#4 - Exit 5 NB Off Ramp/NH 28	No-Build	1.10	51.7	D	1.04	37.7	D	Current lane use per I93 project
	Alternative A	1.11	63.0	E	0.99	39.2	D	Current lane use per I93 project
	Alternative B	1.03	50.2	D	0.93	33.9	C	Current lane use per I93 project
	Alternative C	1.02	49.9	D	0.87	27.7	C	Current lane use per I93 project
	Alternative D	1.02	50.5	D	0.89	32.6	C	Current lane use per I93 project
	Alternative F	1.07	44.0	D	0.99	35.1	D	Current lane use per I93 project
#5 - NH Rte 102/Londonderry Rd/ St. Charles Street	No-Build	0.85	17.7	B	1.16	67.5	E	Add 2nd E-W lane per Woodmont concept
	Alternative A	0.52	11.4	B	0.58	14.8	B	Add 2nd E-W lane per Woodmont concept
	Alternative B	0.48	7.2	A	0.54	14.2	B	Add 2nd E-W lane per Woodmont concept
	Alternative C	0.52	8.2	A	0.53	13.1	B	Add 2nd E-W lane per Woodmont concept
	Alternative D	0.56	8.3	A	0.65	16.3	B	Add 2nd E-W lane per Woodmont concept
	Alternative F	0.75	12.3	B	0.87	27.9	C	Add 2nd E-W lane per Woodmont concept
#6 - NH Rte 102/Fordway/Madden Hill Road	No-Build	0.92	30.8	C	1.04	47.3	D	Current lane use
	Alternative A	0.79	23.4	C	0.99	42,5	D	Current lane use
	Alternative B	0.80	23.0	C	0.91	29.1	C	Current lane use
	Alternative C	0.78	22.3	C	0.92	30.0	C	Current lane use
	Alternative D	0.81	23.2	C	0.94	30.2	C	Current lane use
	Alternative F	0.93	28.7	C	0.96	29.9	C	Add NB LT, EB RT lanes
#7 - NH Rtes 102/28	No-Build	0.88	47.4	D	0.79	37.5	D	Current lane use
	Alternative A	0.89	55.3	E	0.84	47.9	D	Current lane use
	Alternative B	0.87	44.1	D	0.80	40.5	D	Current lane use
	Alternative C	0.77	35.0	C	0.84	40.2	D	Current lane use
	Alternative D	0.89	48.1	D	0.86	46.2	D	Current lane use
	Alternative F	0.63	28.6	C	0.83	34.0	C	Add NB LT, WB Th, EB RT lanes

Table 11 (Cont'd)
Summary of 2040 Capacity Analyses by Alternative

Signalized Intersections

Intersection	2040 Alternative	AM Peak Hour v/c ratio	AM Peak Hour Average Delay	AM Peak Hour LOS	PM Peak Hour v/c ratio	PM Peak Hour Average Delay	PM Peak Hour LOS	Comments/ Lane Use Revisions
#9A - Connector Rd/N High St	No-Build		n/a/			n/a/		Does not exist
	Alternative A	0.59	25.0	C	0.95	37.5	D	Prop lane use: EB - T,T,R; WB-L,T,T; NB- L,L,R lanes
	Alternative B		n/a/			n/a/		Does not exist
	Alternative C		n/a/			n/a/		Does not exist
	Alternative D		n/a/			n/a/		Does not exist
	Alternative F		n/a/			n/a/		Does not exist
#10 - N High/Folsom/Franklin Sts.	No-Build		n/a/			n/a/		Would remain unsignalized
	Alternative A	0.65	17.9	B	0.92	32.2	C	EB - L,T,T,TR; WB-L,T,TR; SB- LT,R; NB- L,TR lanes
	Alternative B		n/a/			n/a/		Would remain unsignalized
	Alternative C		n/a/			n/a/		Would remain unsignalized
	Alternative D		n/a/			n/a/		Would remain unsignalized
	Alternative F		n/a/			n/a/		Would remain unsignalized
#11- Ross' Corner (Folsom/NH 28)	No-Build	0.72	91.3	F	0.80	56.4	E	Current lane use
	Alternative A	0.56	22.3	C	0.79	32.9	C	Add 2nd EB LT and Th lanes; add 2nd WB Th lane
	Alternative B	0.49	28.4	C	0.66	38.3	D	Current lane use
	Alternative C	0.73	32.5	C	0.83	46.1	D	Current lane use
	Alternative D	0.73	27.0	C	0.80	35.2	D	Add 2nd EB LT lane; add 2nd WB RT lane
	Alternative F	0.61	32.6	C	0.72	42.7	D	Current lane use
#12 - Tsienneto Rd/Pinkerton St	No-Build		n/a/			n/a/		Would remain unsignalized
	Alternative A	0.61	13.7	B	0.65	12.5	B	Signalized and coord with Ross' Corner
	Alternative B		n/a/			n/a/		Would remain unsignalized
	Alternative C		n/a/			n/a/		Would remain unsignalized
	Alternative D	0.69	20.1	C	0.64	24.2	C	Signalized and coord with Ross' Corner
	Alternative F		n/a/			n/a/		Would remain unsignalized
#13 -NH 28/Linlew Dr	No-Build	0.41	18.9	B	0.48	17.2	B	Current lane use
	Alternative A	0.19	11.7	B	0.46	25.0	C	Current lane use
	Alternative B	0.36	6.3	A	0.49	13.8	B	Current lane use
	Alternative C	0.39	5.2	A	0.49	12.9	B	Current lane use
	Alternative D	0.56	14.9	B	0.78	20.4	C	Current lane use
	Alternative F	0.28	11.3	B	0.40	16.1	B	Current lane use
#14 - NH 28/Ashleigh Dr	No-Build	0.43	17.3	B	0.59	24.8	C	Current lane use
	Alternative A	0.35	17.0	B	0.48	21.7	C	Current lane use
#22 - B/C Connector/NH 28	Alternative B	0.73	26.8	C	0.83	35.6	D	Revised Lane Use: EB- L,T,R; WB-L,L,T,TR; NB-L,T,T,R,R; SB-L,T,T,R

Table 11 (Cont'd)
Summary of 2040 Capacity Analyses by Alternative
Signalized Intersections

Intersection	2040 Alternative	AM Peak Hour v/c ratio	AM Peak Hour Average Delay	AM Peak Hour LOS	PM Peak Hour v/c ratio	PM Peak Hour Average Delay	PM Peak Hour LOS	Comments/ Lane Use Revisions
#22 - B/C Connector/NH 28	Alternative C	0.71	22.0	C	0.84	29.7	C	Revised Lane Use: EB- L,L,T,TR; WB-L,T,TR; NB-L,TR; SB-LT,R
	Alternative D	0.58	21.0	C	0.84	34.8	C	Add WB RT lane to current lane use
	Alternative F	0.38	16.9	B	0.55	26.2	C	Current lane use
#18 - NH Byp 28/Tsienneto Rd	No-Build	0.69	58.1	E	0.90	112.0	F	Current lane use
	Alternative A	0.64	33.6	C	0.80	23.8	C	Add 2nd EB/WB Th lanes
	Alternative B	0.54	32.4	C	0.59	33.0	C	Current lane use
	Alternative C	0.58	23.9	C	0.79	28.4	C	Current lane use
	Alternative D	0.56	25.2	C	0.60	22.9	C	Add 2nd EB/WB Th lanes
	Alternative F	0.74	32.4	C	0.87	34.8	C	Current lane use
#19 - NH 102/Tsienneto Rd, coord w/	No-Build *	0.53	24.9	C	1.53	247.7	F	LOS as unsignalized
#26 - NH 102/North Shore Rd	Alternative A	0.62	13.2	B	0.76	19.6	D	Add EB LT, WB RT lanes at signal
	Alternative B	0.60	11.0	B	0.61	9.9	A	Add EB LT, WB RT lanes at signal
	Alternative C	0.60	12.7	B	0.60	9.0	A	Add EB LT, WB RT lanes at signal
	Alternative D	0.63	12.1	B	0.65	6.9	A	Add EB LT, WB RT lanes at signal
	Alternative F*	0.30	24.3	C	1.46	247.5	F	LOS as unsignalized
#20 - Exit 4A SB off ramp/Connector Rd	No-Build		n/a/			n/a/		Does not exist
	Alternative A	0.97	41.2	D	0.88	28.9	C	2 SB LT lanes from off-ramp, 2 WB LT lanes to on-ramp
	Alternative B	1.04	52.3	D	0.94	34.6	C	2 SB LT lanes from off-ramp, 2 WB LT lanes to on-ramp
	Alternative C	0.73	20.1	C	0.65	18.3	B	2 SB LT lanes from off-ramp, 2 WB LT lanes to on-ramp
	Alternative D	0.70	19.2	B	0.63	18.2	B	2 SB LT lanes from off-ramp, 2 WB LT lanes to on-ramp
	Alternative F		n/a/			n/a/		Does not exist
#21 - Exit 4A NB off ramp/Connector Rd	No-Build		n/a/			n/a/		Does not exist
	Alternative A	0.93	20.4	C	0.84	16.1	B	EB - T,T; WB T,T,R,R; NB- LR,R
	Alternative B	0.97	27.5	C	0.88	15.8	B	EB - T,T; WB T,T,R,R; NB- LR,R
	Alternative C	0.65	7.9	A	0.58	7.1	A	EB - T,T; WB T,T,R,R; NB- LR,R
	Alternative D	0.59	5.7	A	0.53	5.1	A	EB - T,T; WB T,T,R,R; NB- LR,R
	Alternative F		n/a/			n/a/		Does not exist
#23 - B/C Connector Road/NH Bypass 28	No-Build		n/a/			n/a/		Does not exist
	Alternative A		n/a/			n/a/		Does not exist
	Alternative B	0.25	17.0	B	0.32	16.9	B	Prop lane use: EB- L,T,TR; WB- L,T,TR; NB-L,TR; SB-L,T,R
	Alternative C	0.37	18.5	B	0.46	20.4	C	Prop lane use: EB- L,TR; WB- L,TR; NB-L,TR; SB-L,T,R
	Alternative D		n/a/			n/a/		Does not exist
	Alternative F		n/a/			n/a/		Does not exist

Table 11 (Cont'd)
Summary of 2040 Capacity Analyses by Alternative
Signalized Intersections

Intersection	2040 Alternative	AM Peak Hour v/c ratio	AM Peak Hour Average Delay	AM Peak Hour LOS	PM Peak Hour v/c ratio	PM Peak Hour Average Delay	PM Peak Hour LOS	Comments/ Lane Use Revisions
#25 - C/D Connector Road/NH 28	No-Build		n/a/			n/a/		Does not exist
	Alternative A		n/a/			n/a/		Does not exist
	Alternative B		n/a/			n/a/		Does not exist
	Alternative C	0.81	10.6	B	0.79	12.2	B	Prop lane use: EB- L,T,T; WB- T TR, SB- L,R
	Alternative D	0.96	13.7	B	0.87	14.1	B	Prop lane use: EB- L,T,T; WB- T TR, SB- L,R
	Alternative F		n/a/			n/a/		Does not exist

#1 – Exit 4 SB off-ramp at NH Route 102

The results show that this ramp terminal as presently proposed will still experience capacity constraints into the 2040 design horizon. All 4A Build interchange alternatives appear to function better than No-Build, with Alternatives A and B doing better than the northerly or no interchange alternatives, even though they both have a higher potential development scenario for Woodmont Commons than the others. The heavy SB right turn onto NH Route 102 from the ramp, even with two lanes, combined with heavy WB flow from the NB ramps located to the east, contribute to the decline in LOS. The single left turn lane from the off-ramp also appears insufficient to handle the peak hour demands.

#2 – Exit 4 NB ramps at NH Route 102

The results show that this ramp terminal as presently proposed will also experience capacity constraints into the 2040 design horizon. All 4A Build interchange alternatives improve 2040 AM peak hour operations, with Alternatives C and D doing slightly better than Alternatives A and B in the PM peak. The heavy EB left-turn onto the on-ramp, even with two lanes, is the dominant volume at this location, as well as the NB left turn from the off-ramp. Alternatives C and D appear to operate at a slightly better LOS, but the Woodmont Commons development scenario is also less intense in these cases than under Alternatives A and B. Alternative F fares worse than any of the alternatives as proposed.

#3 – Exit 5 SB ramps at NH Route 28

The results show that this ramp terminal as presently proposed will still experience some capacity constraints into the 2040 design horizon. All 4A Build interchange alternatives provide better operations than the No-Build condition. The single WB left turn and SB right-turn lanes appear to be the constraints to better operations across all alternatives. Alternatives C and D appear to function better than No-Build or the southerly or no interchange alternatives, likely because of their proximity to this interchange and the increased likelihood of diverting some of the traffic demand, as opposed to the other alternatives.

#4 – Exit 5 NB ramps at NH Route 28

The results show that this ramp terminal as presently proposed will also experience capacity constraints into the 2040 design horizon. All 4A Build interchange alternatives provide slightly better operations than under No-Build conditions. The heavy EB left-turn demand onto the on-ramp in a single lane, as well as the single-lane NB left turn from the off-ramp, are the critical movements at this intersection. Alternatives C and D appear to operate at a slightly better LOS than Alternatives A and B, again because of their proximity to this interchange and increased likelihood of diverting some of the traffic demand. Alternative F fares worse than any of the alternatives as proposed.

#5 – NH Route 102/Londonderry Road/St. Charles Street
With the addition of a second east-west through lane on NH Route 102 as part of the proposed Woodmont Commons improvements, this intersection would operate at acceptable LOS under all alternatives. Alternative F would operate slightly worse than the other alternatives, because of projected increased traffic on NH Route 102, but would still be at an acceptable LOS.

#6 – NH Route 102/Fordway/ Madden Hill Road
This existing intersection would operate at acceptable LOS under all alternatives except Alternative F. Alternative A appears to draw more traffic to the Madden Hill Road approach that opposes the heavy Fordway volumes on the same permissive phase (where both approaches have a concurrent green light and must wait for gaps in opposing traffic to proceed), so it operates slightly worse than the other interchange alternatives, particularly in the 2040 PM peak. Alternative F would necessitate provision of lane separation out of Fordway as well as an exclusive EB right-turn lane to maintain an acceptable LOS.

#7 - NH Routes 102/28
Based solely on the capacity calculations, this existing intersection would operate at acceptable LOS under all alternatives except Alternative F. As noted earlier, there are many other unquantifiable factors in the downtown area, such as pedestrian activity and friction from side street and on-street parking maneuvers, that contribute to reduced traffic speeds and the general diversion/avoidance of the area by through traffic to other routes such as Ash Street Extension, North High Street, Folsom Road, and Tsienneto Road.

The traffic model indicates that Alternative A appears to draw more traffic to the eastern part of downtown that then makes a right turn to NH Route 28 in the direction of Exit 4A and the Woodmont Commons development. In reality, much of this traffic may divert to the traffic circle to the east and use the Pinkerton/Tsienneto corridor to complete such a trip. Other Build alternatives show similar operational/LOS characteristics than under No-Build conditions. With additional traffic through the downtown area and no interchange option, Alternative F would necessitate provision of a second NB left-turn lane, an EB exclusive right-turn lane, and a second WB thru lane to maintain an acceptable LOS in the 2040 design horizon.

#9A - Alternative A Connector Road/North High Street
This new intersection is created by the Alternative A connector road with the local street network. The existing intersection of North High Street with Madden Road would be relocated off the new connector road as a minor roadway serving the small number of residences there. It is envisioned that this new intersection would need to be signalized and widened to provide acceptable operations, given the projected traffic volumes. The Connector Road eastbound approach would consist of two thru lanes and an exclusive right-turn lane to North High Street. The Connector Road westbound approach would consist of an exclusive left-turn lane and two thru lanes. The North High Street northbound approach would

consist of two left-turn lanes and a right-turn lane. Given the projected volumes and this lane use, this intersection would operate at a LOS D in the 2040 PM peak hour.

#10 - Alternative A Connector Road/Franklin Street/Franklin Street Extension
This existing intersection is presently unsignalized and operates at a poor LOS for the north/south side street approaches, which experience difficulty entering the main traffic flow during peak periods. With the increase in development activity nearby, this condition would be exacerbated into the future to the point where there may need to be consideration of additional improvements to provide acceptable operations, even with other interchange alternatives beyond Alternative A.

With the Alternative A connector road in place, this intersection will require significant widening and signalization to provide sufficient lanes to handle the project volumes as a direct result of Exit 4A. The east/west approaches would have at least two thru lanes (the projections suggest a third lane may be needed for the eastbound approach) with exclusive left-turn lanes. The north/south approaches would have two lanes with an exclusive lane oriented to the west to handle the projected traffic. This configuration would operate at a LOS C in the 2040 PM peak hour.

#11 - Ross' Corner (NH Route 28/Folsom Road/Tsienneto Road)
This intersection was upgraded several years ago to provide a second southbound left-turn lane from NH Route 28 onto Tsienneto Road to serve the predominant southbound-to-eastbound travel demand between I-93 and Derry and points to the east. With the projected growth to 2040, the existing lane geometry will no longer be sufficient to meet the expected traffic demands.

With an Exit 4A interchange in place, and with the Alternative A connector road in particular, the existing north-south traffic orientation now becomes an east-west flow. As such, improvements to handle the increase east-west travel demand will be required. With Alternative A, a second EB left-turn lane and second EB thru lane will be needed, as well as a second WB thru lane, to provide an acceptable LOS. Alternatives B and C are on a new east-west alignment north of this intersection so no changes to the existing lane use are required. With Alternative D, the interchange is north of this intersection, so movements oriented in that direction will need to be augmented. This means the addition of a second EB left-turn lane and second WB right-turn lane at this location. Alternative F maintains the existing traffic distribution, and the existing lane use can accommodate the projected traffic volumes.

#12 - Tsienneto Road/Pinkerton Street (Alternatives A and D only)
This intersection is in close proximity (300 feet +/-) from the Ross' Corner signal, but is not currently signalized. As such, left-turn exits experience lengthy delays while waiting for a gap in the Tsienneto Road traffic flow. The eastbound right-

turn movement has been separated from the main traffic stream by a channelizing island to help exiting traffic, but the opposing traffic flow limits the number of available gaps for exiting traffic. At some point in the future, regardless of this project, this intersection may need to be signalized and coordinated with the Ross' Corner signal, but there are no defined plans to do that at this time. Therefore, except for those alternatives that directly impact this intersection, namely Alternatives A and D, the intersection is assumed to remain unsignalized and is expected to operate at a poor LOS for the minor street approach from Pinkerton Street.

For Alternatives A and D, a second lane for thru traffic would be provided in both the eastbound and westbound directions, as well as an exclusive westbound left-turn lane into Pinkerton Street. With this geometry and coordinated phasing with Ross' Corner as a cluster intersection, this location would operate at an acceptable LOS C or better in the 2040 design year.

#13 - NH Route 28/Linlew Drive
No changes to the existing lane use at this intersection are required to accommodate traffic volumes under any of the proposed alternatives.

#14/22 - NH Route 28/Ashleigh Drive/Alternative B-C Connector Road
This intersection would see significant changes depending on which alternative would be in place. For Alternatives B and C, the proposed connector road would create a new east-west roadway that would require reconfiguration of lanes to accommodate the new distribution of traffic for either a southerly or northerly interchange. Under Alternative B, the new roadway would need two thru lanes in the east-west direction, as well as double-turn lanes to and from NH Route 28 to the south, along with other lane use changes. With Alternative C, a double SB left-turn lane into Ashleigh Drive would be needed to serve traffic from the new interchange to the north and the connector road, among other lane use changes. An acceptable LOS C or better can be provided for all alternatives with the appropriate revisions to the lane use.

#18 - NH Route 28 Bypass/Tsienneto Road
The 2040 No-Build analysis shows that the existing intersection would operate at or over capacity during both peak hours, so some improvements would appear to be needed at some point in the future. Alternatives B and C reduce east-west traffic through this intersection, so the existing lane use can provide an acceptable LOS D or better in 2040. Alternatives A and D will require the addition of a second east-west thru lane to accommodate the increased east-west traffic at an acceptable LOS.

#19/26- NH Route 102/Tsienneto Road/North Shore Road (Alternatives A-D)
A review of the existing traffic counts at the North Shore Road and English Range Road intersections indicate that existing 2015 left-turn volumes currently satisfy turn-lane warrants at both locations. As such, any improvements at the Tsienneto

Road/NH Route 102 intersection associated with any of the alternatives should take this into consideration in the design.

Because existing PM peak analyses already indicate a poor LOS for exiting traffic, combined with the projected increase in left-turn volumes exiting Tsienneto Road, it has been assumed that this location will need to be signalized as part of any interchange alternative. Because of the proximity of North Shore Road, that intersection would be incorporated into the signalized intersection, similar to Ross' Corner and Pinkerton Street. An exclusive right-turn lane would be provided for NH Route 102 WB traffic entering Tsienneto Road, as well as a WB left-turn lane into North Shore Road. This left-turn lane would also be carried easterly towards the English Range Road intersection for continuity, where an EB left turn lane would be provided. There would still only be a single lane exiting Tsienneto Road, despite the higher volumes, because of the complexity of accommodating a double left-turn lane onto NH Route 102 and then tapering back to a single lane with North Shore Road being so close.

With signalization of the intersection as proposed, an acceptable LOS C or better can be provided for all interchange alternatives in the 2040 design horizon.

#20/21 - Exit 4A SB and NB Ramp Terminals (Alternatives A-D)
With either a northerly or southerly interchange, it is envisioned that both ramp terminals would be signalized as part of the diamond configuration. The SB off-ramp would have two lanes exiting the ramp, while there would be two lanes provided for the left turn onto the SB on-ramp. This ramp would be close to capacity in the 2040 AM peak hour, assuming full realization of the traffic projections on the SB off-ramp.

At the NB ramps, there would be two east-west thru lanes with a single EB left-turn lane and double WB right-turn lanes onto the NB on-ramp. On the off-ramp, there would be a shared left/right lane and an exclusive right-turn lane, since there is no access to the west. An acceptable LOS D or better can be provided at this ramp terminal under all interchange alternatives.

#23 - NH Route 28 Bypass/B-C Connector Road (Alternatives B and C)
This new intersection is created by the connector road roughly along the alignment of the existing Ashleigh Drive. With Alternative B, two east-west thru lanes need to be provided so that an acceptable LOS C can be achieved. Only one east-west thru lane is required with Alternative C because of less overall traffic volume through the intersection.

#25 - C-D Connector Road/NH Route 28 (Alternatives C-D)
This new intersection is created by the connector road from the northerly interchange where it would intersect with the existing two-lane section of NH Route 28 just north of the Derry/Londonderry town line. NH Route 28 southbound would become the minor approach to the intersection and would have

separate left- and right-turn lanes. The EB approach would have an exclusive left lane and two thru lanes, while the WB approach would have a thru lane and a shared thru/right lane. This configuration would provide a LOS B during the 2040 peak hours.

16. Unsignalized Intersections

A summary table showing a comparison of operations at each existing or proposed unsignalized intersection is provided in Table 12. In most cases, the existing or projected deficiencies for the minor street approaches are exacerbated, except where traffic diversions may reduce the volume of traffic on the major approach that would conflict with traffic turning from the minor street approach(es).

It is not envisioned that any of these intersections would warrant signals, except those that are directly impacted by a specific alternative, such as Tsienneto Road/Pinkerton Street or NH Route 102/Tsienneto Road/North Shore Road. Delays at the North High Street /Ash Street Extension and the North High Street/Folsom Road/Franklin Streets locations are excessive and should be monitored as the Woodmont Commons development progresses to determine if and when signal warrants may be satisfied.

Table 12
Summary of 2040 Capacity Analyses by Alternative
Unsignalized Intersections

- Intersection	2040 Alternative	AM Peak Hour v/c ratio	AM Peak Hour Average Delay	AM Peak Hour LOS	PM Peak Hour v/c ratio	PM Peak Hour Average Delay	PM Peak Hour LOS	- Comments/ Lane Use Revisions
#8 - N High St/Ash St Ext	No-Build	1.04	78.0	F	3.04	>300	F	
(Critical Movement - EB LT)	Alternative A	0.53	17.4	C	1.47	228.8	F	
	Alternative B	0.42	14.3	B	0.96	56.5	F	
	Alternative C	0.76	29.3	D	1.09	90.6	F	
	Alternative D	0.74	25.7	D	1.70	>300	F	
	Alternative F	0.74	27.1	D	1.79	>300	F	
#10 - N High/Folsom/Franklin Sts.	No-Build	0.20	21.8	C	0.55	82.0	F	NB all is critical
(Critical Movement varies between NB and SB)	Alternative A		n/a/			n/a/		Signalized
	Alternative B	0.94	96.5	F	3.00+	>300*	F	NB all is critical
	Alternative C	1.35	219.6	F	3.31	>300*	F	SB all is critical
	Alternative D	0.22	10.9	B	1.21	160.2	F	
	Alternative F	0.36	31.7	D	2.31	>300	F	NB critical in AM, SB critical in PM
#12 -Tsienneto Rd/Pinkerton St	No-Build	0.25	16.1	C	0.97	84.0	F	
(Critical Movement - NW LT)	Alternative A		n/a/			n/a/		Signalized
	Alternative B	0.89	80.0	F	1.00	126.4	F	
	Alternative C	2.04	>300*	F	2.54	>300*	F	
	Alternative D		n/a/			n/a/		Signalized
	Alternative F	0.65	66.1	F	4.10	>300	F	
#15 - NH 28/Scobie Pond Rd	No-Build	1.01	144.7	F	0.58	32.2	D	
(Critical Movement - SB all)	Alternative A	0.18	14.4	B	0.19	16.4	C	
	Alternative B	0.18	13.3	B	0.23	16.5	C	
	Alternative C	0.67	>300*	F	4.44	>300*	F	
	Alternative D	1.34	>300*	F	6.67	4259.8*	F	
	Alternative F	0.31	27.4	D	0.47	51.0	F	
#16 - NH 102/NH Byp 28/E Derry Rd	No-Build	0.87	31.9	D	1.26	151.2	F	
(Traffic Circle-RT only)	Alternative A	1.11	94.0	F	0.92	41.9	E	
(HCM 2010)	Alternative B	0.77	21.4	C	0.68	16.4	C	
(Critical Movement - E Derry Rd)	Alternative C	0.73	18.8	C	0.78	21.7	C	
	Alternative D	0.84	28.3	D	0.89	33.6	D	
	Alternative F	0.91	40.1	E	1.21	128.7	F	
#17 - NH Byp 28/Pinkerton/Nesmith	No-Build	-	-	F	-	-	F	Left turns from Nesmith
(HCM 2010)	Alternative A	1.01	138.9	F	0.52	55.3	F	
(Critical Movement - WB all)	Alternative B	1.13	188.1	F	0.53	57.3	F	
	Alternative C	0.96	127.6	F	0.41	41.7	E	
	Alternative D	1.35	280.7	F	0.63	78.3	F	
	Alternative F	0.45	26.2	D	0.46	49.1	E	
#24 - B/C Connector Rd/Tsienneto Road	No-Build		n/a/			n/a/	-	Does not exist
(Critical Movement - NB LT)	Alternative A		n/a/			n/a/	-	Does not exist
	Alternative B	0.09	38.9	E	0.00	0.0	A	
	Alternative C	0.00	0.0	A	0.00	0.0	A	
	Alternative D		n/a/			n/a/	-	Does not exist
	Alternative F		n/a/			n/a/		Does not exist

Table 12 (Cont'd)
Summary of 2040 Capacity Analyses by Alternative

Unsignalized Intersections

- Intersection	2040 Alternative	AM Peak Hour v/c ratio	AM Peak Hour Average Delay	AM Peak Hour LOS	PM Peak Hour v/c ratio	PM Peak Hour Average Delay	PM Peak Hour LOS	- Comments/ Lane Use Revisions
#27 - NH 102/English Range Road	No-Build		n/a/			n/a/	-	
(Critical Movement - SEB all)	Alternative A	0.17	20.8	C	0.16	28.4	D	
	Alternative B	0.23	24.5	C	0.22	26.1	D	
	Alternative C	0.17	20.8	C	0.23	42.1	E	
	Alternative D	0.17	21.0	C	0.18	32.8	D	
	Alternative F	0.17	20.8	C	0.16	28.4	D	

* - calculated delay exceeds 300s

17. Findings and Conclusions

The results of the traffic modeling for the Project indicates that the provision of a new interchange on I-93 will provide varying levels of traffic relief to NH Route 102 east of Exit 4 and into the downtown Derry area by the 2040 design year, as shown in Table 7.

Examples on key links include:

- NH Route 102 east of Exit 4: In the 2040 No-Build case, there is projected to be 41,725 vpd on this segment. Alternative A provides the most relief on this segment (-51.5%) to a volume of 20,240 vpd, which is the same magnitude as the 2015 base volume. Alternative B shows a 48% reduction, while Alternatives C and D show lesser reductions. Alternative F shows a slight increase in projected traffic than any interchange alternative.
- NH Route 102 east of Griffin Street (downtown): Alternatives A, B and C show similar reductions, on the order of 19-21%, or 3000-4000 vpd, over 2040 No-Build conditions. Alternative D shows a lesser reduction, but still lower volume than the 2015 base. Alternative F projects higher volumes than any interchange alternative and would be higher than either the 2015 or 2040 No-Build case.
- Volumes on the Exit 4 ramps are lower under most interchange alternatives, with Alternative A providing the most overall relief over No-Build conditions, even under the highest potential development scenario for the Woodmont Commons development.
- Volumes on the Exit 5 ramps see the highest traffic reductions under Alternatives C and D (northerly interchange) than under a southerly interchange scenario.

Mainline freeway facilities operational analyses indicates that the four-lane I-93 mainline will function at an acceptable LOS C or better under all scenarios, with a couple of exceptions where two-lane on- or off-ramps may be needed to accommodate all projected volumes. A sensitivity analyses of the Exit 4A SB off-ramp indicated that a 200-vph reduction in the assigned traffic would allow this ramp to function as a single lane off-ramp if these traffic projections are not fully realized.

The Exit 4 ramps would have slightly higher volumes under either Alternatives A or B, but this is more reflective of the higher potential development scenario assumed for the Woodmont Commons development than for Alternatives C, D or F, which use the same scenario as the No-Build condition. As noted earlier, should the 23% internal capture rate for Woodmont Commons trips be realized in some form, the number of trips assigned to the study area network may be reduced accordingly, which should result in better traffic operations than the worse-case scenario assumed in this study.

The level of intersection improvements needed to accommodate the alternative and connector road corridors vary greatly depending on alternative. In general, all intersections can provide an acceptable LOS under any alternative with appropriate lane use and signalization/coordination as required. The traffic circle at NH Route 102/NH Route 28 Bypass will continue to function at a poor LOS regardless of alternative.

In summary, from a purely traffic standpoint, Alternatives A appears to best satisfy the Purpose and Need for the Project by providing the greatest reductions in NH Route 102 traffic through downtown Derry than the other alternatives evaluated. Volumes on NH Route 102 just east of Exit 4 would be roughly half of 2040 No-Build levels and similar to existing (2015) conditions. Alternative B provides some relief as well, but primarily serves a north-south trip pattern as opposed to the east-west pattern needed to reduce traffic on NH 102 in downtown Derry. Alternatives C and D would provide some, but not as much, relief to the NH Route 102 corridor, because of the increased distance between these northerly interchange alternatives and the NH Route 102 corridor.

Other natural and cultural resource impact criteria will be used to provide the final assessment of the Preferred Alternative, but the previous finding of Alternative A as the Preferred Alternative from a traffic standpoint is supported by the updated analyses contained herein.

18. References

AASHTO (American Association of State Highway Transportation Officials). 2011. Policy on Geometric Design of Highways and Streets. American Association of State Highway Transportation Officials. Washington DC, 2011.

CLD, 2018, Traffic Technical Memo, Estimate of Contribution of Woodmont Commons Traffic to Exits 4 and 4A, February 5, 2018

CLD|Fuss & O'Neill, 2018, Minutes from Traffic Working Group/EIS Review Team meeting, February 20, 2018

FHWA. 2007. I-93 Exit 4A Interchange Study Derry-Londonderry Draft Environmental Impact Statement. July 2007.

Google 2018, Google Inc. Google Maps, Accessed January, 2018

Louis Berger. 2017. Land Use Scenarios Technical Report.

Louis Berger, 2018, Interstate Justification Report, April, 2018

McTrans, 2018. McTrans Center, University of Florida, Highway Capacity Software (HCS), Version 6.90, 2018,

NHDOT, 2009, Supplemental Environmental Impact Statement and Reevaluation/Section 4(f) Evaluation, August 2009, Tables 4-12 and 4-13.

NHDOT. 2016a. Bureau of Traffic, Traffic Reports. https://www.nh.gov/dot/org/operations/traffic/tvr/routes/documents/i-93.pdf.

NHDOT. 2016b. Bureau of Traffic, Traffic Reports. Available at: https://www.nh.gov/dot/org/operations/traffic/tvr/routes/documents/nh-28.pdf.

NHDOT. 2016c. Bureau of Traffic, Traffic Reports. Available at: https://www.nh.gov/dot/org/operations/traffic/tvr/routes/documents/nh-102.pdf.

NHDOT, 2016d. Bureau of Traffic, Seasonal Adjustment Factor report, 2015

NHDOT, 2016e. Email from John Butler (NHDOT) to CLD, dated November 7, 2016

NHDOT, 2016f. Email from John Butler (NHDOT) to CLD, dated July 21, 2016

NHDOT. 2017a. Email from John Butler (NHDOT) to CLD, dated May 25, 2017

NHDOT. 2017b. Email from John Butler (NHDOT) to CLD, dated March 8, 2017

NHDOT. 2017c. Email from Nick Sanders (NHDOT) to CLD, dated October 12, 2017

NHDOT. 2017d. Email from John Butler (NHDOT) to CLD, dated June 20, 2017

NHDOT. 2018. FY 2018 – FY 2028 Ten Year Plan. Available at: https://www.nh.gov/dot/org/projectdevelopment/planning/typ/documents/20180116-10-year-transportation-recommendations.pdf.

SNHPC. 2017. FY 2017 – FY 2040 Regional Transportation Plan for the Southern New Hampshire Planning Commission. Available at: http://www.snhpc.org/pdf/FinalRegionalTransportationPlan2017-2040.pdf.

TEC, 2013. Woodmont Commons Planned Unit Development, A Master Plan, Section 4.2 Master Plan Traffic Impact Assessment – Supplemental Documents, Sept. 2013.

Texas A&M, 2017. Transportation Planning Implications of Automated/Connected Vehicles on Texas Highways, April 2017.

Town of Derry, 2015. Town Zoning Map, effective 8/6/2015

Trafficware 2016. Trafficware, LLC, Sugarland TX, Synchro plus Sim-Traffic. Version 9, 1998-2016

Transportation Research Board (TRB), 2000. Highway Capacity Manual, 2000

Transportation Research Board (TRB), 2010. Highway Capacity Manual, 2010

Transportation Research Board (TRB), 2016. Highway Capacity Manual (HCM6), 2016, Chapter 22, Roundabouts