David T. Hartgen
2015-07-28
FINAL Affidavit for I-77 HOT Lanes Analysis

STATE OF NORTH CAROLINA COUNTY OF MECKLENBURG	IN THE GENERAL COURT OF JUSTICE SUPERIOR COURT DIVISION 15-CVS-1076
WIDENI77, a North Carolina nonprofit association, Plaintiff, vs. NORTH CAROLINA DEPARTMENT OF TRANSPORTATION, an agency of the State of North Carolina, and I-77 MOBILITY PARTNERS LLC, a Delaware limited liability company, and STATE OF NORTH CAROLINA, Defendants.	**AFFIDAVIT OF DAVID T. HARTGEN Regarding Economic Impacts of the I-77 HOT lanes Project**

NOW COMES **David T. Hartgen**, being first duly sworn, and deposes and says that:

1. **I am over the age of 18 (eighteen)** and I am now and was at all times stated herein competent to testify to all matters herein stated.

2. Except to the extent that I make reference to other materials, **I make this affidavit of my personal knowledge.**

3. **Qualifications.** My qualifications for preparing this Affidavit are that I have degrees in civil engineering from Duke University (BS, 1966) and from Northwestern University (MS, 1967;

Ph.D., 1973) where I specialized in transportation planning. I have about 48 years of experience in transportation planning and analysis, including 22 ½ years in state and federal government with the New York State Department of Transportation and the Federal Highway Administration, 17 ½ years as a Professor of Transportation Studies at UNC Charlotte, and 8 ½ years consulting in transportation issues, as President of The Hartgen Group. I am an Adjunct Scholar at the John Locke Foundation a North Carolina good-government organization, and the Reason Foundation a national good-government organization based in California. I am US Co-Editor of the academic journal *Transportation*, and am active in professional activities particularly the Transportation Research Board, a branch of the National Academy of Sciences. I am the author of 379 reports and publications on a wide variety of transportation issues, 115 of which relate to transportation issues in North Carolina. I am quoted regularly in Charlotte-area, other local and national media regarding transportation issues. I have operated travel demand models similar to that used in the I-77 HOT lanes study, including a large study of seven proposed toll roads in and around the Los Angeles area. Although I was formerly a licensed Professional Engineer (Maine), I have recently retired my license and I do not practice engineering. My comments below will therefore be confined to economic issues and travel demand modeling, which are not engineering subjects. My brief CV is attached as Attachment 1.

4. **Independent assessment.** I am not a resident of the I-77 corridor, I do not own land or have business interests in the corridor, and I have not been paid for my analysis of the HOT lane economic impacts. Nor have I any arrangements that would benefit me if the proposed HOT lane proposal were canceled, modified, or built as proposed.

5. **Familiarity.** As a resident of the Charlotte region (Cabarrus County) I occasionally drive the I-77 corridor, including its existing high occupancy vehicle (HOV) lanes. I have also reviewed various technical documents and other materials regarding the proposal, as referenced below.

6. **Basis of Concern**. I am generally in favor of user-supported transportation services, and am not ideologically opposed to or in favor of either high-occupancy-tolled (HOT) lanes or fully tolled roads. As a professional I have even suggested their use in North Carolina, where appropriate[1]. Most of the national examples of HOT lanes are in cities over 1 million population, in corridors with very high traffic volumes, demonstrated need for added capacity, low environmental impact, with options for non-users. But North Carolina has few such cases and the State's experience with toll roads is very limited. There is only one toll road in the State, the Triangle Expressway in Wake County between I-40 and US1, and its traffic volume is only about 20,000 vehicles/day[2], far below its 6-lane capacity of about 150,000/day. The State has no experience with managed HOT lanes, a more complex tolling environment in about 20 examples nationwide. My specific concern regarding the I-77 HOT lane project is that, *as now described, the I-77 HOT Lane project would likely not reduce present or future congestion in the corridor, but instead would likely increase congestion relative to other realistic options. It would also likely have a significant negative long-lasting impact on the local economy, and on the activity patterns*

[1] Hartgen, DT, Transportation priorities for North Carolina, John Locke Foundation, Raleigh NC April 3, 2013. At. http://www.johnlocke.org/research/show/policy%20reports/250.

[2] Volume is higher, about 35,000/day on the sections near I-40. North Carolina Turnpike Authority, Triangle Expressway First Quarter 2015 Operating Statistics Report, May 15, 2015. At http://www.ncdot.gov/projects/triangleexpressway/download/NCTAAnnualOperationsReport2015.pdf

of residents and businesses in the corridor and the region. In my view, the project would also have a substantial risk of financial failure resulting in a future 'bail-out' expenditure of additional scarce taxpayer dollars.

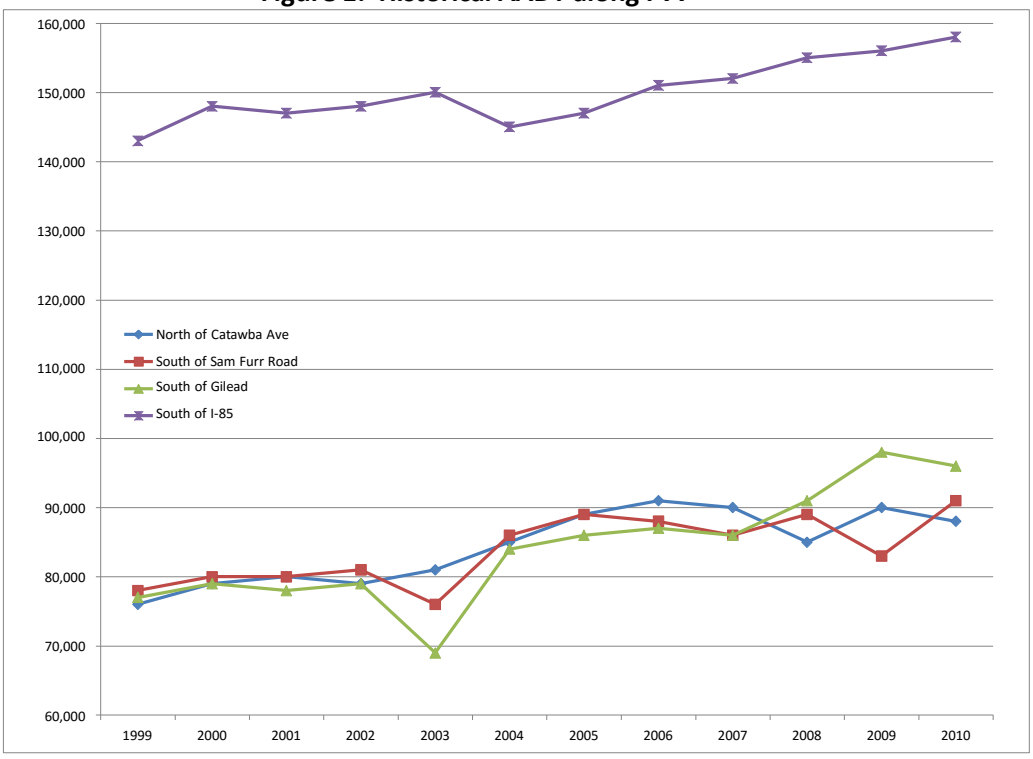
7. **Summary of Affidavit.** The following is a summary of my findings:
    - The region's I-77 corridor is in need of more road capacity, but the case is not made convincingly that the proposed HOT lanes would relieve present or future congestion.
    - Traffic volumes in the I-77 corridor north of I-85 have been flat since 2005, before the recession, and are likely capped by the limited capacity of the general purpose lanes. Congestion is located at several different points in the corridor, and varies by time of day and direction.
    - Providing more general purpose lanes in the corridor would increase its capacity more than providing the proposed HOT Lanes.
    - Direct (user) negative economic impacts on the corridor's travelers are estimated at $ 34.48 B over 50 years, in tolls, travel time delays in general-purpose lanes, increased accident costs and increased vehicle operating costs. Against this cost, HOT lane users are estimated to save about $ 0.64 B in the value of saved travel time, for **a net corridor loss of about $ 33.84 B over 50 years.**
    - Indirect (non-user) negative economic impacts (business losses, land use, land values, air quality, household schedules, emergency access, and local government costs) are not fully quantified, but an estimate of the reduced value of a $ 300,000 residence is estimated at about – 19%, or about $ 57,000, if the predicted increase in travel time occurs on the general purpose lanes.
    - Induced (multiplier) economic effects caused by less household spending are estimated at about $ 15.7 B over 50 years.
    - Although an Environmental Assessment and a Finding of No Significant Impact were issued in 2013, these documents did not review the full range of alternatives, particularly those that would expand general purpose lanes without tolls.
    - In the interim time since the studies were begun, corridor traffic and population growth has slowed markedly.
    - Legal issues continue to be open to question, including whether the time horizon for the project (to 2017) was too short; whether the initial studies are now out-of-date given significant changes in corridor growth; whether the description of the project's forecast assumptions are reasonable, clear, and justified; and whether the forecasts violate the directives of the 4th District Court that land use forecasts for the 'no-build' alternative be different from land use forecasts for the 'build' alternatives.
    - Numerous questions are raised regarding the reasonableness of the assumptions behind the traffic forecasts.
    - The literature on accuracy of traffic forecasts suggests that the inherent uncertainty of traffic forecasts means that even mid-range (5-year) forecasts are subject to considerable error, and possibly optimism bias.
    - A possible 'failure' scenario might follow the experience of Georgia (2011), in which toll rates on I-85 HOT lanes in the Atlanta area were cut 40% by the Governor when the road did not meet traffic projections.

8. **Corridor status and HOT lane proposal.**

- **How does the project fit into the reduction of congestion in the I-77 Corridor?** The DOT's analysis[3] argues that recent traffic growth throughout the I-77 corridor warrants expansion of capacity, and I agree. NCDOT standards for Level-of-Service D capacity[4] indicate that for 4-lane freeways (in urban, piedmont terrain with 6-10% trucks) the LOS D capacity is 65,700 ADT; for 6-lane freeways, 99,600 ADT; and for 8-lane freeways 134,000 ADT. Traffic volumes on I-77 are already substantially above these standards.

  But Figure 1 and Table 1 (below) from their Tech Memo #1 shows on careful inspection that *only traffic volumes south of I-85 have been growing*. North of I-85, traffic growth has been much slower, essentially flat since 2005, even declining in some years, with a recent small tick-up in volume in 2010. This suggests that most of the asserted growth south of I-85 is caused not by I-77 commuting, but by addition of large volumes of traffic from I-85 itself. North of I-85, although the corridor has grown, that population growth has not significantly increased the volume of traffic on I-77. It is likely that the limited capacity of I-77 is slowing traffic growth, but in and of itself neither of these trends implies, per se, the need for a HOT lane on I-77.

Figure 1: Historical AADT along I-77



Source: Tech Memo #1.

[3] Stantec, I-77 HOT Lanes Technical Memorandum #1: Existing Conditions, March 8, 2012, p 2. (In Attachment 2)
[4] NCDOT Transportation Planning Branch, Level-of-Service D Standards for Systems Level Planning, Updated October 14, 2011. Attached as Attachment 3. Level-of-Service D refers to heavy volume flow, at speeds 10-15 mph below free-flow speed but no stop-and-go traffic.

Location	AADT											
	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
North of Catawba Ave	76,000	79,000	80,000	79,000	81,000	85,000	89,000	91,000	90,000	85,000	90,000	88,000
South of Sam Furr Road	78,000	80,000	80,000	81,000	76,000	86,000	89,000	88,000	86,000	89,000	83,000	91,000
South of Gilead	77,000	79,000	78,000	79,000	69,000	84,000	86,000	87,000	86,000	91,000	98,000	96,000
South of I-85	143,000	148,000	147,000	148,000	150,000	145,000	147,000	151,000	152,000	155,000	156,000	158,000
Location	Annual Growth											
	'99-'00	'00-'01	'01-'02	'02-'03	'03-'04	'04-'05	'05-'06	'06-'07	'07-'08	'08-'09	'09-'10	'99-'10
North of Catawba Ave	3.9%	1.3%	-1.3%	2.5%	4.9%	4.7%	2.2%	-1.1%	-5.6%	5.9%	-2.2%	1.3
South of Sam Furr Road	2.6%	0.0%	1.3%	-6.2%	13.2%	3.5%	-1.1%	-2.3%	3.5%	-6.7%	9.6%	1.4
South of Gilead	2.6%	-1.3%	1.3%	-12.7%	21.7%	2.4%	1.2%	-1.1%	5.8%	7.7%	-2.0%	2.0
South of I-85	3.5%	-0.7%	0.7%	1.4%	-3.3%	1.4%	2.7%	0.7%	2.0%	0.6%	1.3%	0.9

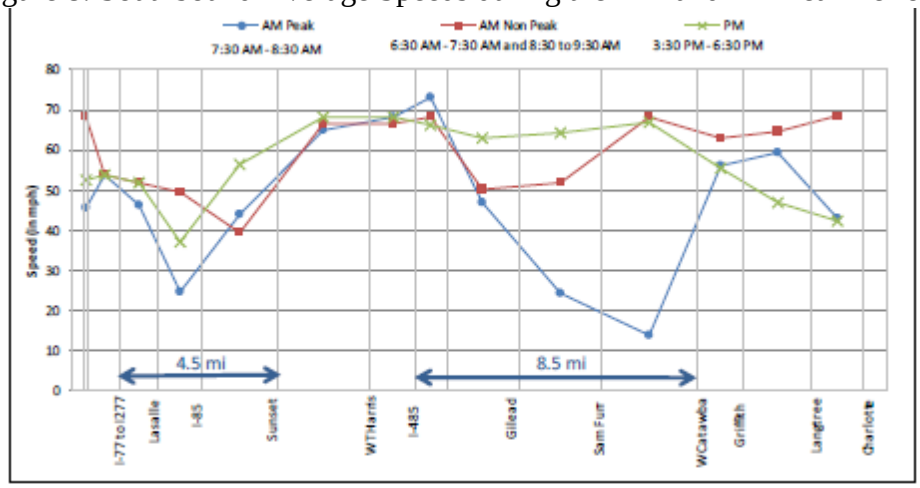
Table 1: Historical AADT along I-77, 1999-2010

Source: Stantec Tech Memo #1 (In Attachment 2).

However**,** traffic trends imply that *more general purpose capacity is needed.* The maximum practical capacity of a modern freeway lane is about 2,400-2,500 vehicles/hour, or about 25,000/day with typical peak hour percentages[5]; in practice most freeways carry less than this volume since exit spacing, lane merges, lane width, geometrics, terrain and traffic characteristics also affect flow rates. As the Stantec memo correctly points out, I-77 both north and south of I-85 is near its practical capacity, each section carrying about 22,000 vehicles/day *per lane*. In other words, the corridor needs more capacity, but not necessarily more HOT lanes.

- **Where is the congestion located?** According to the Highway Capacity Manual, the presence of congestion on freeways can be determined by drops in speed from free-flow speed, usually in peak hours of travel. In the I-77 corridor, the Stantec memo indicates that the locations of congestion are different in the AM and PM peaks[6]. In the following figure, the Southbound AM speeds are lowest in two locations: south of I-85, and between Gilead Road and Catawba Ave, as slow as 15-20 mph.

Figure 8: Southbound Average Speeds during the AM and PM Peak Periods



Source: Inrix Travel Times, October 2011.

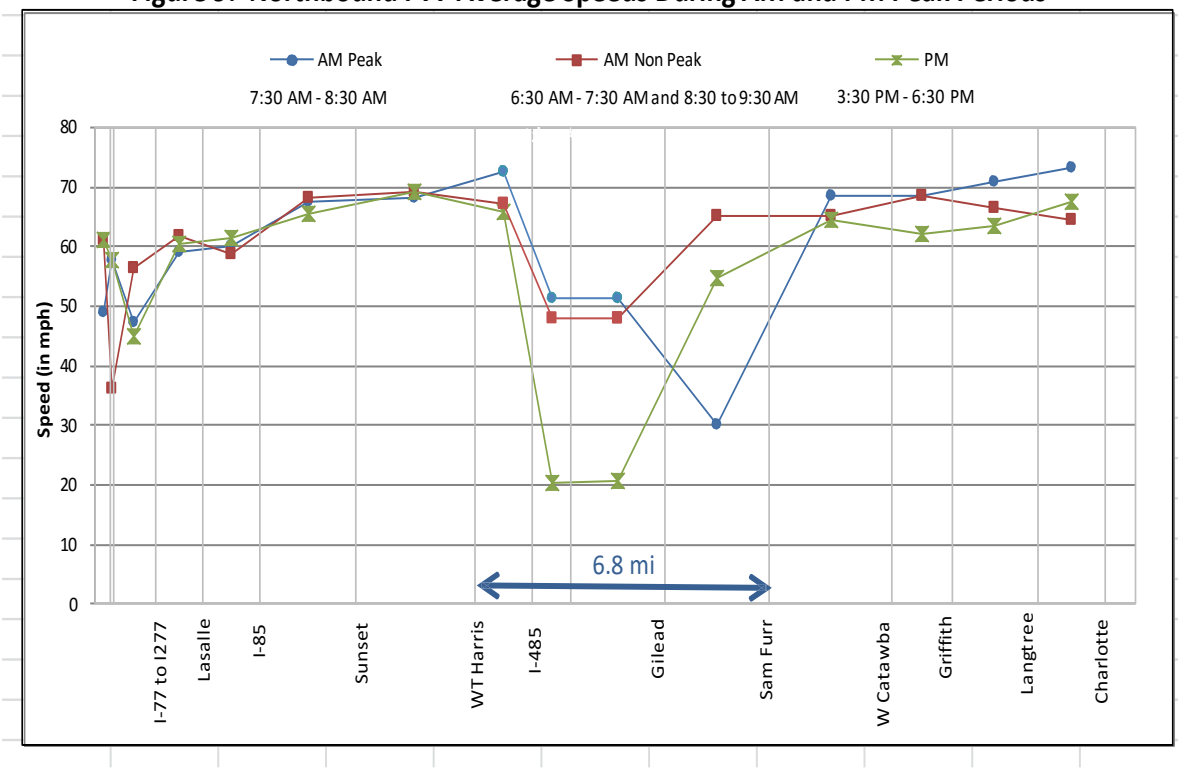
These drops in speed are likely caused by additional large traffic volumes from I-85 itself, and by large merging volumes from Catawba Avenue and Sam Furr Road. This represents an average speed drop of about 45 mph, over a combined distance of about

[5] Transportation Research Board, Highway Capacity Manual, 2010.
[6] Stantec Tech Memo #1, p. 6-10. In Attachment 2.

13 miles. (This data, from the Stantec memo, will be used later in estimating economic losses).

But in the northbound (PM) direction, (Figure 9 below), congestion shows up in different location, between WT Harris and Sam Furr Road, where speeds drop to about 30 mph, a drop of about 40 mph. In the northbound direction, the speed drop is likely caused by the reduction in capacity from 3 lanes (one way) to 2 (one way northbound) north of I-485 and Sam Furr Road, a distance of about 6.8 miles. This data, also from the Stantec memo, shows that the locations of congestion are different by direction, and are short in individual distance relative to the total corridor length, about 24 miles.

Figure 9: Northbound I-77 Average Speeds During AM and PM Peak Periods



Source: Inrix Travel Times, October 2011.

- **What is the HOT lane proposal?** As described in the project documents, the project would convert the present HOV lanes to HOT lanes between about LaSalle St. and above I-485, and add another HOT lane to this section for a total of 2 HOT lanes in each direction. The HOT lanes would allow 3-person cars to use it for free, and others to use for a toll. Toll rates would vary by congestion on the HOT lane assuring an average operating speed of 45 mph. No trucks would be allowed on the HOT lanes. North of the present HOV lanes, one HOT lane would be added, but with no addition to the general purpose lanes. The present general purpose lanes would be retained for general purpose and truck use, but not be expanded for 50 years without compensation to the HOT-lane operators (the so-called 'non-compete' clause). In total, the proposed project is about 26 miles long, with the HOT lanes 24.1 miles long southbound and 24.3 miles long northbound.

- **What would be the effect of adding HOT lanes on the capacity of I-77?** The present HOV lanes, limited to 2-person vehicles, are largely under-utilized even in peak hours, and their current geometrics and difficult exit/entry points also reduces their effective capacity. According to the Census Bureau[7], only about 10.7% of Mecklenburg commuters are in 2+ person carpools, and therefore the current HOV lanes, if fully utilized, would add only about 10% of the capacity of I-77. If opened to general purpose use, the 2 current HOV lanes would represent about 14% increase in capacity[8] below I-85, and a 20% increase in capacity from I-85 to Huntersville. However, if restricted to HOT-lane toll payers and 3+person carpools, their effect would be much less, since only about 2.9% of Mecklenburg County commuters are in 3+-person carpools that would have free access to the HOT lanes, and others would have to pay a toll. Total HOT lane traffic is estimated by Stantec at about 9-10% of total traffic (year 2015)[9], about the same as the current HOV lanes' maximum potential. I later argue that this is unlikely, but being conservative, assume here that adding HOT lanes would likely add about 10% of capacity to the existing system. On the other hand, adding general purpose lanes to the present I-77 corridor would have a substantially greater effect on capacity. The following table shows the effect:

Estimated Effective Capacity of I-77, Lanes in One direction

I-77 Section	Current GP Lanes	Current HOV Lane (effective capacity)	Total Current Capacity	Convert HOV lane to HOT lane	Add 1 more HOT Lane	Convert HOV lane to GP Lane	Add 1 more GP Lane
I-85-Lasalle	4	0.4 effective	4.4	4.4*	5.0	5	6
I-85-I-485	3	0.3 effective	3.3	3.3	3.6	4	5
I-485-Gilead	3	0.3 effective	3.3	3.3	3.6	4	5
Gilead-North of Catawba	2	-	2	-	2.2	-	3

*example: 4 existing lanes + 0.1 capacity of new lanes *4 = 4.4

In other words, adding 'vanilla' general purpose capacity to the corridor, either by converting the existing HOV lanes to GP lanes, or adding more GP lanes, would have the effect of increasing the corridor's existing capacity by as much as 50%, an effective increase greater than that added by HOT lanes.

[7] US Census, American Community Survey, Mecklenburg County NC, 2013. At http://factfinder.census.gov/faces/tableservices/jsf/pages/productview.xhtml?pid=ACS_13_5YR_S0801&prodType=table

[8] 5/4.4 = 1.14; 4/3.3 = 1.21.

[9] Stantec, I-77 HOT Lanes Technical Memo #6, Sept 14, 2012, Table 17-18. Attached (in Attachment 2). Example calculation: (38201 + 33336)/(38201+389740+363785) = 9.5%

9. **Likely Impact on the Regional Economy.** The technical documentation for the project does not offer an estimate of how the proposal will affect the local or regional economy. However, using straightforward principles from transportation economics, it is possible to estimate this impact.

Traditionally, transportation economists estimate the economic impact of proposals using three criteria[10]:

1. **User benefits (or sometimes losses)**, generally achieved from savings in travel time, reduced accidents, and reduced vehicle operating costs.
2. **Indirect impacts** on non-users, e.g. interim construction jobs not paid for by taxes, changes in land value, changes in employment, changes in land use, costs of increased air and noise pollution, and similar impacts;
3. **Induced impacts**, caused by the 'ripple' of benefits or costs through the local economy.

Although there is continuing discussion in the transportation planning community as to how to quantify some of these benefits and costs, we will use a traditional approach here for quantifiable benefits and costs. It should also be noted that tax-based expenditures, such as construction expenditures, are NOT benefits, but transfers from the private to the public sector, so if treated as benefits by the public sector they would have to be treated as a loss to the private sector. In traditional transportation economics, the *source* of funds for construction does not affect costs or benefits, although this sometimes can influence project selection.

The following discusses the main impacts of the costs of the project as now described.

- **I-77 Travel Time Delay.** User travel time delays in the current corridor can be estimated from the Stantec Tech Memo #1. Since the HOT lane study specifically proposes to retain the present configuration of general purpose lanes, the implied delay from the proposal, as compared to a GP widening that would like eliminate the delay, is summarized in the following table:

Estimate of Value of Congestion Delay, GP lanes, I-77 HOT Lanes Project

Direction	Free-flow speed	Congested speed	Distance	Delay per driver, hours	Traffic Affected	Delay hours/day	Value of Delay over 50 years (2015 $)
Southbound	70	25	13 miles	0.334*	12,150**	4058***	$ 3.013 B****
Northbound	70	30	6.8 miles	0.129	12,150	1667	$ 1.164 B
Total							**$ 4.177 B**

***** Travel time delay per driver = (13 miles/70 mph) – (13 miles/25 mph) = -.334 hrs.
** Traffic affected = 90,000 AADT/2 directions*(0.9 traffic on GP lanes)*0.3 daily in 3 peak hours = 12,150
*** Delay/day = 12,150 Affected traffic *0.334 hours/vehicle = 4509
**** Value over 50 years = (4058 hours of delay/day)*330 affected days/year)*(50 years)*($15/hour value of time)*(3 inflation over 50 years).

This estimate is based on conservative assumptions including traffic diverted to the HOT Lanes, and the value of time, generally about ½ the average wage rate weighted

[10] See for example, Economic Analysis Primer, Federal Highway Administration, USDOT, August 2003. At www.fhwa.dot.gov.

for truck traffic[11]. In the Charlotte area, this would be about $ 15/hr. But the estimate does not include the additional delay caused by *growth* in traffic, nor does it include delay on *side streets or parallel routes*. Without a full traffic study of the whole corridor it is not possible to accurately estimate this value, but based on experience it can reasonably be expected to about double the delay to I-77 traffic, or about **$ 4.2 B.**

- **Travel time savings for HOT Lane users**. While general-purpose lane users will lose travel time, HOT lane users will benefit from saved travel time. The Stantec Technical Memo #6[12] allows an estimate of this savings. Combining the data from Table 17 and 22 in the Memo, the following table shows the savings, in minutes, for the Northbound direction, in 2015:

Estimated Savings in Travel Time for HOT lane Users, Northbound, 2015.

Segment/	**Total Daily Volume, HOT Lanes***	**Total Daily Time Savings in minutes**** (average per trip, min)	**Daily Time Savings, Hrs.*****
I-277 to I-85	11,732	6,769 (0.58)	112.8
I-85 to WT Harris	6,325	3,904 (0.60)	65.1
WT Harris –Hambright	3,009	1,009 (0.33)	16.8
Hambright-Catawba Ave	5,832	16,171 (2.77)	269.5
Catawba-Langtree	5,888	15,320 (2.60)	255.3
Langtree-SR150	5,416	3,260 (0.60)	54.3
Total	**38,201**	**46,433**	**773.9**
Total Annual Savings, hrs, NB+SB			510,774****
Annual Value of Saved Travel Time			$ 12.77 M****
Savings over 50 years, $ 2015			**$ 638.5 M*****

*Source: Stantec Tech Memo #6, Table 17.
**Sum of traffic (table 17)*time savings (Table 22) for each section, direction, and time-period.
***example 6769/60 = 112.8.
****773.9 * 2 directions * 330 days/year = 510,774
*****510,774* $ 25/hr. value of time for toll payers = $ 12.77 M
***** $ 12.77 * 50 = $ 638.5 M

The table shows that most of the savings will come from faster travel in 2 of the 6 sections (Hambright Rd. to Langtree Rd.) but even there the average savings, over the day, will be only about 2.6 minutes (the tables in Tech Memo #6 show higher savings in the PM peak, 7-8 minutes, but also most savings in each section of less than a minute). Over 50 years, the estimated value of the travel time savings for HOT lane users is about **$ 638.5 M.**

[11]CDM Smith et al. Analytical Travel Forecasting approaches for Project Level Planning and Design, NCHRP 765, p.233, Transportation Research Board, Washington DC. 2014.
[12] Stantec, I-77 HOT lanes Technical Memorandum #6, Supplemental T+R Information, September 14, 22012. Tables 17 (page 20) and Table 21 (page 24). Attached.

This estimate does not include traffic growth, inflation, or growth in the travel time savings. I note in passing that the travel time savings for HOT Lane users is slightly less than the estimated cost of construction ($ 648 m), raising the question of whether the investment is even viable from a benefit/cost perspective for HOT lane users.

- **User Tolls.** Estimates of user tolls are made in the technical documents[13]. Tolls on the proposed HOT lanes are estimated to begin (2015) at about 0.37-$0.49/mile in 2015; for a one-way trip through the entire length, the toll estimate is $9.05-11.75[14]. For the year 2035, less than halfway through the lifetime of the project, the one-way toll is estimated to be $ 20.60-$ 21.63, in 2012 dollars.

  The estimated user revenue from tolls rises from about $ 20.47 M in 2017 to about $ 704.28 M in 2065, in nominal dollars. Over 50 years, the total user toll revenue sums to $ **12.26 B,** in nominal dollars[15]. This revenue disappears from the region, going primarily to the toll road operator, Cintra, based in Spain. Also, note that the estimated toll revenue, $ 12.26 B, is almost 20 times the value of the travel time savings ($0.639 B), suggesting that the either the estimated revenue is too high, or the estimated toll traffic is too low.

  Transportation planners sometimes argue that, since tolls are voluntarily paid by toll road users, they must provide at least as much economic gain, in the form of saved travel time or improved reliability, as the willing users paid for them. This argument implies that toll revenues, even if they leave the region, are offset economically by local economic gains. However, those gains are not calculable, but lost tolls are. Therefore we treat the tolls paid as a loss to the regional economy, even though some, but not all, of their value is indirectly recouped to toll road users.

- **Accident costs.** Accident costs are a function of traffic volumes, accident rates, and costs of individual accidents, by type. Traffic volumes and accident rates for the I-77 corridor are provided in another technical memo[16]. Using the Atkins memo, the following table indicates the estimated (for 2017) traffic volumes and vehicle-miles of travel (VMT[17]):

Estimate of Corridor Traffic VMT, 2017

[13] Stantec, I-77 HOT Lanes Technical Memo #7: Supplemental Information, September 5, 2013, Table 12 (p.20).
[14] Stantec, I-77 HOT Lanes Technical Memo #6, Supplemental T+R Information, September 14, 2012, Table 20 (p.23).
[15] Ibid.
[16] Atkins, Final Traffic Operations Technical Memorandum, I-77 HOT Lanes, July 2013. P.2ff. Attached as Attachment 4.
[17] A 'vehicle-mile-of-travel', VMT, is a commonly used measure of travel in transportation planning. One 'vehicle-mile' is equal to one vehicle traveling one mile.

Direction	Distance, miles	Average Volume, No-Build, AM+PM	Average Volume, No-Build, Daily	Daily VMT, No- Build	Average Volume, Alt 2, AM+PM	Daily Volume, Alt. 2	Daily VMT, Alt 2	Difference, Alt 2 vs. No-Build
NB	24.3	11,285	56,425	1.371 M	24, 575	122,875	2.712 M	
SB	24.1	10,450	50,700	1.222 M	19,945	99,725	2.403 M	
Total				**2.593 M**			**5.115** M**	**2.522 M**
Total, Annual VMT								**832.26* M**

*Daily VMT * 330 'days'/year. **This estimate is close to the estimate of VMT for a slightly larger network, 5.5 m, reported in the air quality documentation.

Traffic volumes are substantially higher for Build Alternate 2 (the one most similar to the proposed configuration of the HOT lanes) because the opening of the extra lanes attracts traffic from other routes. According to our calculations, the effect is an almost doubling of the I-77 daily VMT. The annual increase in VMT is about 832.26 M.

Conversion of the difference in VMT into accident costs is straightforward. According to the Atkins memo, about 70% of the accidents on I-77 are either rear-end sideswipe, and about 1% are fatal. Using the I-77 corridor's accident rates and average accident costs from federal publications the following table estimates the increase in accident costs.

Estimated Accident Costs of the I-77 HOT Lanes Project

Accident type	**Rate per 100 M VMT, I-77****	**Estimated Annual Increase in Accidents**	**Average Accident Cost[18]**	**Estimated Annual increase in Accident Costs**	**50-Year Increase in Accident Costs**
Fatal	1.02	8.48	$4.538 M	$ 38.5 M	
Injury	33.57	279.3	$ 78,900	$ 21.8 M	
PDO	60*	499.2	$ 8,900	$ 4.4 M	
Total		**787.0**		**$ 64.7 M**	**$ 3.23 B**

*Assumed, based on national statistics showing property-damage-only accident rates are (conservatively) about 2 times the injury-fatal accidents. **Source: Atkins memo.

In other words, the likely impact of the HOT lanes proposal is an increase of about 2.1 accidents, over the current rate of about 2.4 per day, and increases accident costs by about **$ 3.23 B** over 50 years.

This estimate assumes similar accident rates for HOT lane users and GP users. But it does not include adjustments for accident costs due to inflation, which could be substantial. Nor does it include traffic growth, or the likelihood that accident rates on the GP lanes will increase if speeds fall. On the other hand it also does not include potential accident decreases on parallel routes if traffic is diverted to I-77 to use the HOT lanes, Therefore it should be considered as preliminary, but a general indicator of the magnitude of the likely impact of the HOT lanes proposal on corridor accident rates.

[18] National Safety Council, Estimating the Cost of Unintentional Injuries, 2012. Attached as Attachment 5.

- **Increased vehicle operating costs.** Increased vehicle operating costs can be estimated from the increase in VMT, with additional data on costs of operation for different vehicle types. Using data on percentages of vehicles in various classes, applied to the increase in VMT, along with national estimates of unit operating costs per vehicle mile, the following table estimates the impact of the I-77 HOT lanes project.

Estimated Increased Vehicle Operating Costs for the I-77 HOT Lanes Project

Vehicle Class	Percent of Traffic	Increased VMT, Annual	Operating Cost/VMT	Annual Increase in Operating Costs	50-Year Increase in Operating Costs
Cars/SUVs	90	749.0 M	$ 0.20*	$ 149.8 M	
Trucks	10	83. 2 M	$ 0.75*	$ 62.4 M	
		832.2 M		**$ 212.2 M**	**$ 10.61 B**

*Assumed based on national operational studies. Does not include fixed or capital costs.

This estimate does not include adjustments for operating costs due to inflation, which could be substantial. Nor does it include traffic growth, or the likelihood that operating costs per mile will increase if speeds fall. On the other hand it also does not include potential operating cost decreases on parallel routes if traffic is diverted to I-77 to use the HOT lanes, or slightly reduced operating costs for HOT lane users. Therefore it should be considered as preliminary, but a general indicator of the magnitude of the likely impact of the HOT lanes proposal on corridor vehicle operating costs.

- **Summary of direct impacts.** To summarize direct (user) impacts, the components above are added:

Additional travel time costs: I-77 GP users	$ 4.18 B
Additional travel time costs: Other road users	$ 4.20 B
HOT lane user toll costs	$ 12.26 B
Additional accident costs, I-77 GP lanes	$ 3.23 B
Additional operating costs, I-77 GP Users	$ 10.61 B
Total Additional Road User Costs	**$ 34.48 B**
HOT lane user travel time savings	$ - 0.64 B
Net corridor costs, HOT users and non-users	**$ 33.84 B**

So, essentially, the proposal has the effect of rewarding a small number of users of the HOT lanes through saved travel time, but at a very large cost to both users and non-users in the form of tolls, added travel time, added congestion, added accident costs, and added operating costs.

To put these numbers in perspective, the total regional economy of the greater Charlotte region is about $ 118 B annually, in 2005 dollars[19]. The corridor economy is about 1/10 of that, or about $ 12 B. Over 50 years (not assuming

[19] US Department of Commerce, Bureau of Economic Analysis, Gross Domestic Product by Metropolitan Area, 2013. At www.bea.gov/scb/pdf/2013/10%20October/1013_gpd_by_metropolitan_area_%20tables.pdf

growth), the corridor's GDP would be about $ 600 B. So a $ 34 B 'hit' to the local economy would be about a 6% loss of corridor GDP, quite a large amount for a single government action, and about the same as the loss of 7500 jobs for 50 years.

- **Indirect (non-user) economic costs.** In addition to these direct impacts on users, there are other forms of impact that are less easily quantified but are nevertheless real. These take many forms. Among the most likely are:

    - **Business operations and relocations.** The DOTs analysis of I-77s general purpose lanes concludes that travel times will substantially increase. Table 21 from the Stantec Technical Memo #6[20] indicates that corridor end-to-end travel times will increase 32-82%, depending on time and direction. This is a very substantial increase that is likely to affect both businesses and households. As noted above, it is likely to precipitate increased congestion on nearby roads as businesses and households struggle to cope.

      Peak Period End-To-End Travel Times, in minutes, I-77 General Purpose Lanes.

Direction	2015 AM	2015 PM	2035 AM	2035 PM	AM Pct. Increase	PM Pct. Increase
Northbound	26.7	41.5	35.2	69.3	**31.8 %**	**67.0 %**
Southbound	39.4	30.9	71.6	47.1	**81.7 %**	**52.4 %**

      The business effect cannot be measured directly but its overall effect can be determined. This author conducted a recent 1000-sample nationwide survey of how employers view congestion[21]. The study found that about 48 % of suburban employers in growing areas such as the I-77 corridor viewed congestion as a major or moderate problem. Major concerns were increased operating costs, unreliable employee and shipment schedules, job stress, shipment delays, and delays in local business travel during work hours. But most surprising, 37 % of employers indicated a willingness to relocate due to increased local traffic congestion. If this nationwide study is indicative of employer concerns in the I-77 corridor, and the increase in congestion is as predicted, then possibly as high as 40% of corridor businesses will consider relocating. How many actually do, and where they go, is speculative, but one thing is sure: the relocations will leave the I-77 corridor. The likely destinations will be nearby Cabarrus and Gaston Counties, and Rock Hill SC, all of which will be more accessible than the I-77 corridor. This could lead to worsened corridor economic activity, falling business rents, slowed or reversed business development, and longer commutes.

[20] Stantec, I-77 HOT Lanes Technical Memorandum #6 Supplemental T+R information, September 14, 2012. P. 24. Attached.

[21] Hartgen DT et al. How employers view traffic congestion, Transportation research record 2319, Transportation Research Board, 2012. Attached as Attachment 6.

- **Household activities**. Among those most impacted by the I-77 HOT lanes proposal are corridor and ultimately regional households. Contrary to belief, the corridor is not populated by lakeside millionaires, but by ordinary families all along the income spectrum. Of the 64,718 persons living within about 1 mile of I-77, 43% are non-white and 13% are below poverty level[22]. These persons work and shop all over the greater Charlotte region, not just locally. Some work in downtown Charlotte, but most do not.

  If congestion rises by 60%, as predicted by the Tech Memos, increasing travel times in the corridor will affect households in many ways. Work trips will begin earlier and end later, and peak congestion hours will lengthen, eating into other activities. Some jobs will be shifted in time and location as commuters rethink their commute hassles. Other household activities such as school drop-offs will be rearranged to avoid peak hours. Destinations for shopping and recreation will be changed, family carpooling ('fam-pools') for those contemplating HOT lane use might substantially increase, and work-at-home activity will be more popular. Local travelers not using I-77 will find congestion on nearby parallel and feeder routes also substantially increased, as households seek to avoid I-77s increasingly congested general purpose lanes or tolled lanes.

- **Land use patterns**. In our discussion below (Part 11) we note that the land use forecast for the I-77 HOT lanes is invariant across the alternatives, and does not account for the predicted large increase in congestion that the Tech Memos predict. If the predicted increase in general-purpose lane congestion and nearby roads occurs, land use patterns in the future will likely be different than assumed. Some employers and residents are likely to leave the corridor, corridor growth may slow, and other regional corridors will grow more rapidly. Further, if changes are made in the design of the project, particularly if proposed new exits are added, there is likely to be a significant change in land use near those sites. This will therefore affect the amount of induced (attracted) travel in the corridor. While these effects are speculative, they are even not discussed in the Community Impact Assessment.

- **Land values**. An important second-order effect of the increased congestion will likely be changes in land value. Generally land values increase with increasing access, and decline if access worsens. One recent study of suburban house sales in 5 large Texas cities[23] found that a 1-minute increase in commuting time is correlated with a drop in house value of $ 1.90 per square foot. Applying these findings to the I-77 situation, the predicted 12-minute increase in commute time through the corridor would translate into

[22] Atkins, TIPS # I-3311C, I-5405, and I-4750AA, Mecklenburg and Iredell Counties, Community Impact Assessment and Indirect and Cumulative Effects Screening Assessment, May 2013. Table A1. (Source: US Census, Block Group Statistics, 2010). Attached as Attachment 7.

[23] F. Qiao et al, Impacts of average commuting time on housing prices in Texas suburban cities. Transportation Research Record #3729, Transportation Research Board, Washington DC, 2015. At www.trb.org/trid.

a loss of housing value of about $ 22.80/sf. For a 2500sf house, that means a loss of about $ 57,000 in value, or about 19 % for a $ 300,000 house. This is very substantial loss indeed. Of course, other homes might see a smaller effect.

Estimates of effects for commercial land are less studied, but one study also from Texas[24] found that a 1-minute increase in commute time was correlated with a $ 24/month decrease in apartment rental rates. If this relationship holds for the I-77 corridor, then a 12-minute increase in commute time would result in lower apartment rental rates of about $ 288. For a $ 1200/month apartment, that would be about 24% loss of rental revenue, but that savings might then be spent locally.

Transportation economists are divided about whether such impacts should be added to user costs, or whether they just reflect the changed willingness of residents to trade off housing and commuting decisions. While not definitive, these studies suggest that one significant effect of a sharp increase in commute time in the I-77 corridor would be a major drop in residential and commercial land value.

- **Barrier, emergency and evacuation impacts.** In addition to providing faster travel for some trips, major highways such as Interstates also can be barriers (similar to rivers) that can constrain and consolidate cross-corridor travel. This effect shows up as increased bunching of traffic on that cross or lead to the Interstate. In the I-77 case, the impact of barrier effects is accounted for in the increased travel time and increased congestion as residents drive on the local road network. It is therefore included in our discussion of travel time costs above.

  But the additional impact on specialized services, such as medical responses and access to hospitals, is not accounted for. While relatively small as a total percent of corridor travel, such travel is of course vitally important to the individuals involved, so its impact needs to be considered. In a study for another toll road proposal in Virginia, this author estimated that a 3-minute improvement in EMS response times (from receipt of a 911 call to arrival at the site of a cardiac event) would result in a 6% reduction in cardiac mortality[25]. So, if the I-77 HOT lane project worsened average EMS response time by 3 minutes (quite a lot), about a 6% increase in cardiac mortality might be expected. However, since EMS vehicles generally have right-of-way in existing traffic, the presence of more congestion per se would not affect response time, but a change in access to a given hospital might have a similar effect.

  As part of the same study this author also analyzed the impact on fire emergency services[26]. Fire services also have right-of-way in traffic, so

[24] Michelle Bina et al, Location choice vis-à-vis transportation: apartment dwellers. Transportation Research Record #1977, TRB, Washington DC, 2006. At www.trb.org .

[25] Hartgen DT et al. Impacts of the Mid-Town tunnel (Portsmouth VA) improvements on EMS mortality. Unpublished memorandum, March 4, 2009. Attached as Attachment 8.

[26] Hartgen DT et al. Impacts of the Mid-Town Tunnel (Portsmouth VA) on Fire Response and Damages. Unpublished memo, March 4, 2009. Attached as Attachment 9.

the effects of congestion on travel time are not as great as they are for other drivers. But a change in road access could affect response times for some properties. The effect of a 3-minute savings in response time was estimated to be a reduction of about 1% of insured property value, but only for those properties affected by the savings. So, a 3-minute worsening of response time (quite a bit, for most communities), would raise insurance rates for affected properties by about 1%.

Impacts on regional evacuation plans, for instance in response to a hurricane are more problematical. Although hurricanes in the Charlotte area are rare, they do occur – witness Hurricane Hugo, September 19, 1989 – but even Hugo did not prompt an evacuation order. Regarding an emergency at the McGuire Nuclear Facility near the corridor, nuclear facilities generally have evacuation plans that detail how nearby residents and business will be evacuated in the event of an emergency. For the Cornelius area, these plans call for the use of I-77 north to Exit 45 (north of Mooresville), and State Route 73 east to Cabarrus County[27]. At the very least, these plans need to be updated if the I-77 HOT lanes are built, given the likelihood of more background congestion on I-77s general purpose lanes.

- **Air quality.** The air quality impacts of the I-77 HOT lane project are estimated in another technical document[28]. In this document, analysis is undertaken ONLY for the mainline I-77 traffic and the proposed HOT lanes:

  "CO emissions were modeled for vehicles traveling along the mainline freeway section contained within the project limits. While this project does add some traffic to the network, it primarily redistributes traffic between the mainline and the HOT lanes." (p.4).

  *T*he result of this analysis, for CO, is shown in the following table:

Table 1
Comparison of Model Results to Ambient Air Quality Standards for CO (Receptor 73 at a Wind Angle of 10 Degrees)

Measurement Period	NAAQS (ppm)	2017 No-Build Conditions	2017 Build Conditions		
			Alternative 1	Alternative 2	Alternative 3
1-hour (peak)	35	6.2	6.8	6.9	6.5
8-hour	9	5.1	5.6	5.7	5.3

Source: Gibilaro et al, p. 5

This table purports to show that, for each of the three alternative HOT lane configurations tested, CO emissions in 2017 will be above the no-build conditions, but lower than the NAAQS standards. But the analysis is flawed

[27] Town of Cornelius Critical Incident Evacuation Routes, undated (accessed 7/5/15). Attached as Attachment 10
[28] Gibilaro C and Fluitt A, Microscale Carbon Monoxide and Mobile Source Air Toxics Air Quality Analysis: I-77 HOV-HOT Conversion, Kimley-Horn Associates, Revised June 2013. Attached as Attachment 11.

for several reasons. First, the analysis assumes a very near time horizon (2017) and an 11 percent increase in road VMT from 2010 to 2017, but does not forecast CO emissions out to 2035, the forecast year for demand modeling, or to 2065, the forecast year for financial analysis. It therefore conveniently ignores the projected increase in congestion on the general purpose lanes and the reduction in speed predicted by Tech Memo #7. Second, by narrowing the analysis to just I-77 lanes, the analysis conveniently ignores the secondary effect of congestion on nearby feeder and parallel routes. These two effects together are substantial, and probably render the air quality impact problematical.

- **Local government costs.** There are other costs to corridor residents that are not easily quantified but are also nevertheless real. Local governments will need to make additional improvements to local streets, over and above those planned now, to account for the predicted increase in congestion. As noted earlier, higher numbers of accidents are likely to require additional police, EMS and other services. Specialized services such as re-zonings are likely to increase in response to pressures on land use, necessitating additional employees. Local area plans need to be updated. While some of these activities might occur anyhow and are the appropriate purview of government, the additional effort caused by the I-77 HOT lane project is not included. Of course, these costs fall on local taxpayers.

- **Induced (multiplier) economic impacts.** Induced (multiplier) economic impacts are commonly discussed in studies of economic impact. The idea of an economic multiplier is that as dollars are added or subtracted from an economy, the effect is expanded (multiplied) as the added or removed dollars affects other unrelated businesses. A common example of a positive multiplier is the additional grocery shopping that occurs when the employees of a new company move to a suburb, and a common negative example is the loss of shopping business if a major employer closes or a bypass diverts traffic away from a city. Detailed analysis of multipliers requires the use of specialized software (sometimes called input-output models) that considers the interaction of all elements of a regional economy, and that assessment should have been done here by the I-77 HOT Lane planners. As an approximation, we use the value of 1.6 for an estimate of the household economic multiplier[29]. The direct financial outlays by corridor households caused by the I-77 HOT lanes is about $ 26.1 B over 50 years (not counting travel time impacts based on the value of time). The multiplier effect adds about 60% to $ 26.1 B, or about **$ 15.7 B.** In other words, the greater Charlotte regional economy is 'slowed' by the loss of expenditures that I-77 Corridor residents pay out in tolls, vehicle operation and accidents.

[29]US Dept. of Commerce, Bureau of Economic Analysis, RIMS II An Essential Tool for Regional Developers and Planners, 2012, p. 25. At http://bea.gov/regional/pdf/rims/RIMSII_User_Guide.pdf.

10. **Other solutions not seriously considered.** The I-77 HOT lane analysis considered only a narrow range of alternatives. These are described in several documents[30] as follows:
    - ***"Alternative 1** – 1 HOT lane in each direction from I-227 (Exit 10C) to just north of I-85, 2 HOT lanes in each direction from just north of I-85 to West Catawba Avenue (Exit 28), 1 HOT lane in each direction from West Catawba Avenue (Exit 28) to NC 150 (Exit 36), and a direct connection of HOT lanes to and from I-277.*

    - ***Alternative 2** – 2 HOT lanes in each direction from I-277 (Exit 10C) to West Catawba Avenue (Exit 28), 1 HOT lane in each direction from West Catawba Avenue (Exit 28) to NC 150 (Exit 36), and a direct connection of HOT lanes to and from I-277.*

    - ***Alternative 3** – 1 HOT in the southbound direction from I-277 to just north of I-85, 2 HOT lanes in each direction from just north of I-85 to West Catawba Avenue (Exit 28), and 1 HOT lane in each direction from West Catawba Avenue (Exit 28) to NC 150 (Exit 36)."*

    Although these alternatives may have been appropriate when the Environmental Assessment was prepared, recent changes in the methods of funding roads in North Carolina other than the tolling method assumed here, allow for a wider range of alternatives to be looked at. These other alternatives include:
    - **Add a single general purpose lane in each direction from Hambright Road to Mooresville**. This option, probably the cheapest, would eliminate several current bottlenecks, but not provide enough capacity for longer-term growth or address corridor congestion below Hambright Road.
    - **Convert the current HOV lane in each direction to general purpose lanes south of Hambright Road, and add a single general purpose lane in each direction to I-77 north of Hambright Road to Mooresville**. This option would add incremental capacity over the intermediate time frame, perhaps 15 years, allowing for other technologies such as connected-vehicles to mature. This would probably be relatively low cost but it would probably not fully eliminate congestion in the corridor.
    - **Build 2 new general purpose lanes in each direction from Hambright Road to Mooresville.** This option would alleviate several of the most severe congestion locations, and likely be less expensive than full corridor improvement, but its environmental impacts would be larger
    - **Add one additional general purpose lane in each direction for the entire project length, but retain the current HOV lane**. This option would be more expensive than conversion, but buy more time for growth, perhaps 20 years, and would allow for a later tolling of the HOV lane, if needed in the future.
    - **Convert the present HOV lane in each direction to general purpose lanes, as above, but add an additional general purpose lane the entire corridor length.** This option would be more costly but more effective, adding enough capacity to handle about 30-40- years of growth, when the entire corridor would need rehabilitation and future vehicle driverless-car technology will significantly affect capacity. However

[30] For instance, Gibilaro et al, op. cit. attached as Attachment 11. Also, USDOT and NCDOT, I-77 High Occupancy/Toll (HOT) Lanes, Finding of No Significant Interest, October 16, 2013. Attached as Attachment 12.

environmental issues would be more severe regarding crossing Lake Norman and possibly requiring some additional right-of-way.

It is not my intention here to suggest s specific solution to the corridor's traffic problems; that would be presumptuous, and NCDOT and its consultants are eminently capable of evaluating various options in detail. Rather, the intent is to show that numerous other reasonable options are also possible. If this project were being initiated now rather than 10 years ago, NEPA rules requiring the analysis of all reasonable options would certainly require that such options be considered.

11. **Legal issues are unresolved.** In addition to the above concerns, there are, in my view, a number of significant legal issues remaining regarding the proposal. I am not a lawyer, so I defer to legal experts to review these issues, but in dealing with road projects over the years and understanding the methods used to forecast traffic, the following issues seem to be apparent:

- **Too short time horizon**. Several of the I-77 HOT lane documents I reviewed generally use traffic forecasts to 2017, from a base year of 2010. Such a short time horizon precludes looking further out into the future, not only for the road traffic itself, but also for the impact of the project on the surrounding road system. In addition, the use of a short time horizon may be a violation of NEPA regulations.
- **Length of time since Feasibility Study**. The Feasibility Study for the project was completed in 2009, according the NCDOT website:

  "*A feasibility study was conducted in 2009 to consider converting existing HOV lanes on I-77 to express lanes and extending the converted lanes to Catawba Avenue (Exit 28) in Cornelius*"[31]

  The Environmental Assessment (EA) for the project was signed on July 3, 2013, and the Finding of No Significant Impact (FONSI) on October 16, 2013.

  However since 2009 several major events have occurred that have affected the project. The national recession 2008-10 slowed Charlotte-region growth. Since then some growth has resumed, but the Charlotte area MPO has recently revised its growth forecasts for the whole area downward; they now call for a slower employment growth, +57% from 2010 to 2040, compared with a faster employment growth, 74.6%, for 2005 to 2035 in the prior plan[32]. In another memo[33], these lower numbers are also used. This is a very significant slow-down for an employment forecast in just 5 years, reflecting the effects of the 2008-10 recession.

  As I understand NEPA regulations, there is no requirement for an EA or EIS to be updated on a regular basis if a project has been delayed, the criterion being instead the presence of significant events that cause the EA/EIS to be out of date. Certainly a significant slow-down of growth forecasts would be one of these, since it would affect the justification for the proposed improvements and maybe even eliminate or delay their need. At the least, the impact of the recently revised population and employment forecasts on the traffic forecasts and the need for the project should be investigated.

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[31] Source: NCDOT website, http://www.ncdot.gov/projects/I-77ExpressLanes/, accessed 7/3/2015.

[32] Sources: Charlotte Regional Transportation Planning Organization, 2040 Metropolitan Transportation Plan, April 20, 2014; and 2035 Long Range Transportation Plan, March 4, 2010. At www.crtpo.org.

[33] Stantec, I-77 HOT lanes Technical Memorandum #3 Model Application and Forecasts, May 21, 2012, p. 3ff. Attached.

- **Just one land use forecast.** In a 2012 case[34] involving another proposed toll road in the greater Charlotte area (the Monroe Connector/Bypass in Union County), the US 4th District Court of Appeals ruled that the land use forecasts for the 'no-build' alternative did in fact include the 'build' road in the assumptions of growth allocation. This led the Court to require an additional analysis of the induced (road-caused) land use and its associated traffic. The same land use forecast was likely used in the I-77 HOT lane study, and in that study only one land use forecast was prepared[35], and there was no evaluation of separate land use scenarios for the 'build' and the 'no-build' alternatives. This is inconsistent with the statement on the NCDOT website that they are now considering changing the proposed HOT lane access configuration to a point south of Westmorland Road:

  "*The contract requires only one access point between Exits 13 and 18, but NCDOT's partner, Cintra, is proposing two access points. Cintra can recommend shifting these locations, but any change must be first approved by NCDOT and local stakeholders. Currently, Cintra is considering moving the access point between Exit 25 and Westmoreland Road to south of Exit 25, then adding another access point north of Westmoreland Road*."[36]

  A change of this magnitude, adding an exit and moving another, would certainly change the land use. At the very least, a review should be made as to whether the I-77 HOT Lane proposal is subject to the directives of the 4th District Court.

- **Inadequate transparency of the traffic forecast.** Traditionally, courts have been reluctant to challenge traffic forecasts made by NEPA lead agencies, deferring to the lead agency's technical expertise; the courts focus instead on whether the administrative process follows NEPA and other regulations. However, in a recent court case from Wisconsin[37], a court ruled that the justification for a proposed road widening between Fond-du-Lac and Sheboygan was inadequate since: 1. The forecast used population forecasts that had prepared before the recession and were not updated to include recent lower state forecasts; and 2. The study team did not adequately describe the method used to forecast traffic.

  The issue of slower population growth is discussed above. Regarding the description of traffic forecasting, there are numerous examples in the I-77 HOT Lanes discussion of model calibration and traffic forecasting memoranda, where unsupported and/or unclear assumptions or procedures are described, among which are the following:

  In **Tech Memo #2[38]** (**Socioeconomic and Land Use**), the following items are omitted or only briefly discussed:

  - No estimate of *corridor* growth data is provided (p.3 of tech memo);

[34] US Court of Appeals for the Fourth Circuit, Case 11-2210, NC Wildlife Federation e.t al. vs. NC Department of Transportation, et al. Decided May 3, 2012. Attached as Attachment 13.
[35] Stantec, I-77 HOT lanes Technical Memorandum #3 Model Application and Forecasts, May 21, 2012, p.3ff. Attached.
[36] Source: NCDOT website, http://www.ncdot.gov/projects/I-77ExpressLanes/, accessed 7/3/2015.
[37] US District Court Eastern District of Wisconsin, Case 11-C-0545, 1000 Friends of Wisconsin Inc. vs. US Department of Transportation et al. Decision and Order, filed 5-22-2015. Attached as Attachment 14.
[38] Stantec, I-77 HOT Lanes Technical Memorandum #2 Socioeconomic and Land Use, March 8, 2012. Attached.

- No discussion on why the Metrolina Regional Model's employment numbers for 2015 were arbitrarily lowered by 13%, to meet an actual growth rate (from 2005) of just 2%, Further this growth reduction was assumed to be proportional across the entire region, without any justification. (p. 12 of tech memo).
- No discussion of why the corridor growth is assumed to return to 2.25% annually after the recession. The report provides no data supporting this assumption, and in any event it would be presumptuous to assume that rate continues into the future. (p.12).

In **Tech Memo #3[39] (Model Calibration),** the following items are omitted or only briefly discussed:

- The map (p 3) used to show the regional network shows US 321 in Gaston County as an arterial, when it is in fact an expressway; the detailed sub-area map (p.6) shows NC 16 in Lincoln County as an arterial when it is in fact an expressway.
- No discussion of the source and accuracy of trip generation data for land parcels within the corridor.
- No discussion of the source and accuracy of trip distribution tables showing origins and destinations in the sub-area.
- No discussion of the appropriateness of traffic assignment parameters, e.g. those slowing travel times as congestion builds up (p.6).
- No data on trip length distributions comparing estimated and actual trip lengths for trips generated within the study area.
- No explanation of the basis for further lowering of trip table flows by 10-11% (p. 18);
- No discussion of the source and accuracy of *external trips* entering or leaving the study area, e.g. on I-77 south of the project, or on I-77 north of Mooresville, or trips crossing the sub-area. These trips are likely to be as much as half of all traffic, if the study area boundary is limited to the area near I-77.
- No discussion of why value-of-time estimates from Austin TX are assumed to be appropriate for use in this corridor, since route choice coefficients from the Metrolina Regional Model would have been readily available. (p.8).
- No explanation of why the diversion coefficients used in the toll-diversion equation are proprietary, and if so, then how can they be evaluated for use in Charlotte (p.5);
- No discussion of how current traffic shifts between time periods to avoid peak hour congestion.
- No clear discussion of how much Interstate speeds were raised to better match observed speeds (p.14).
- No discussion of why mid-day flows were used as the calibration standard, when the focus of the project is to alleviate peak-hour congestion (p.14).

[39] Stantec, I-77 HOT Lanes Technical Memorandum #3 Model Calibration, March 3, 2012. Attached.

- No clear discussion of how a 30-50% *overestimate* of the base-year observed traffic was then addressed in the calibrated model (p.11-13).
- No clear explanation of why current employment estimates in the Mecklenburg County was arbitrarily lowered by 7.6%, and regional employment lowered by 12.8%, to better match traffic volumes on I-77. (This would imply a drop of 22.8% in current non-Mecklenburg employment, a huge change.) (p.14).
- No discussion of how estimates of I-77 capacity were lowered 6-8%, and why (p.2).
- No data showing the accuracy of the base-year traffic estimates to actual counts, by road, direction, and time of day. The calibration 'accuracy' focuses on screen-line matching, not matching of trips on I-77.
- No explanation of why, after calibration the AM (southbound) peak estimated speeds on I-77 were 40 mph, as opposed to 15-20 mph in the field.
- No reference to calibration estimates of traffic in the existing *HOV* lanes.
- No reference to the modeling of the *reliability*[40] of traffic flow, an increasingly important issue in transportation planning and an issue specifically important for the I-77 corridor and used as the basis for justifying reliable travel times in HOT lanes.

In summary, the discussion of calibration comes across as a series of incompletely described steps intended to get the regional model to match screen-line volume crossing the I-77 corridor, and to a lesser extent flows and travel speeds on I-77. Since these essentially arbitrary actions are then carried forward into the traffic forecasts for the alternatives, they must be supported as reasonable and necessary.

In **Tech Memo #4[41] (Model Application and Forecasts),** the following issues are apparent:

- The use of a single land use forecast for both the 'build' and the 'no build' alternatives, in apparent violation of the 4th District Court directives, and inconsistent with other documents that show major new exits along the facility that would change local land use.
- Failure to explain how the adjustments made in model calibration are carried forward in the forecasts.
- The use of a very short time horizon (2017) for traffic forecasts which is inconsistent with the 2035 travel time forecasts and 2065 financial forecasts reported in Tech Memo #7.
- The use of a critical assumption (p.7) that the value of time will increase at 3.7% per year. This assumption is inconsistent with the large literature on the value of travel time that places it, in average, at about ½ the wage

[40] *Reliability* is usually defined as the variation in travel times around an expected mean value. There are several procedural manuals for dealing with reliability in traffic forecasts.
[41] Stantec, I-77 HOT Lanes Technical Memorandum #4, Model Application and Forecasts, May 21, 2012, Attached.

rate, not on household income, as in the HOT lane study. The recommended values-of-time, from a recent best-practices report[42] are:

Table 9-6. Value of Travel Time (source: NCHRP Report 765, 2014).

Market	Value of Time
Commute	40–50% of Wage Rate
Personal Travel	30–40% of Wage Rate
On the Clock Travel	100% of Wage Rate

Further, wage rates in the Charlotte are unlikely to grow at 3.7% into the future. Therefore, the assumption that the value of time will increase by 3.7% annually is not justified by either the data or best-practice. This assumption is critical because, the higher the value of time, the higher the diversion to the toll road.

- The assumed ramp-up time is probably optimistic. Recent data from Raleigh's Triangle Expressway shows traffic volumes on this 6-lane road still under 20,000/day, even after 3 years of opened service.

In **Tech Memo #6 (Supplemental Information**), the following issues implied from the traffic and revenue forecasts are apparent:

- The assertion that January 2015 employment for Mecklenburg employment is 630,000, (p.6) when the actual employment (from the North Carolina Department of Commerce) is 511,289, a difference of about – 19%. This difference is in addition to the reductions made in the model calibration effort, described above, and is a serious inconsistency, clearly showing that the employment and travel forecasts use in the I-77 HOT lanes study are optimistic.
- The unstated but also critical assumption that the traffic forecasts for the HOT lanes is based on *average* (typical weekday) route choice behavior by regional travelers. But as the forecasts of revenue and traffic show (Tech Memo #6, page 23-25), the implied value of time for HOT-lane users is $ 25-36/hour, not the average $ 15.83/hour used in the traffic model.

Implied Values of Time for HOT Lane Users

Year-Direction	Time Savings, minutes*	Toll, 2011 $**	Implied Value of Time, $/hour***
2015 NB PM	19.4	$ 11.75	$ 36.34
2015 SB PM	17.4	$ 9.05	$ 31.20
2035 NB PM	47.0	$ 21.63	$ 27.61
2035 SB AM	49.3	$ 20.60	$ 25.07

[42] CDM Smith et al. Analytical Travel Forecasting approaches for Project Level Planning and Design, NCHRP 765, p.233, Transportation Research Board, Washington DC. 2014.

*Source: Table 22, Tech Memo #6, p. 25.
** Source: Table 20, Tech Memo #6, p.23.
***Example calculation: $ 11.75 toll *60 minutes/hour /19.4 minutes saved = $ 36.34 toll paid/hour of time saved

These values of time are 1.7-to-2.5 times the values of time used in model calibration (average $ 15.83). This means that use of the HOT Lanes will not be an 'average' behavior for most corridor travelers, but instead will be a rare behavior, taken when time is valuable (e.g., fixed activity schedules, airport departures, medical appointments, etc.).

- **Use of small travel time savings to justify the project.** The viability of the project rests on the assumption that *all* HOT-lane users will first see, and then save, enough travel time to warrant out-of-pocket expenditure for tolls. But careful inspection of Table 22 in Tech Memo #6 shows that most of the travel time savings in each section, direction and time of day are less than 1 minute; only a 12 of the 96 examples shown are greater than 5 minutes. The modeling process used in the study assumes that all travelers will see and react to all these little time savings. But it is highly doubtful that potential HOT users would even perceived these savings, or take advantage of them for short trips even if they did see them.

These are just a few of the major inconsistencies and unclear sections in the reports that document the traffic and revenue forecasts. In total, they shed great doubt on the accuracy – or even the reasonableness – of the traffic forecasts, and possibly even the need for the project. As the Wisconsin case concluded, the project justification has to be both reasonable and clear. In my opinion, it is neither.

- **Inherent uncertainty of traffic and revenue forecasts.** It is generally recognized in transportation planning that traffic forecasts are uncertain, but the magnitude of the problem has only recently been studied. Several world-wide studies of toll roads[43] [44] and other major projects have found that 20-year forecasts of toll road traffic ('transactions') are unlikely to be within 30% of their pre-construction estimate. In the US, a study[45] of accuracy of 15 toll road traffic forecasts found average revenue under-forecasting error of -35% after 5 years, and only 3 of the 15 roads studied were above initial projections after 5 years. All three studies also suggest a tendency for over-estimating traffic, sometimes called "optimism bias". Although no recent studies of traffic forecast accuracy have been done in the US, these findings suggest extreme caution in using even short-range revenue forecasts.

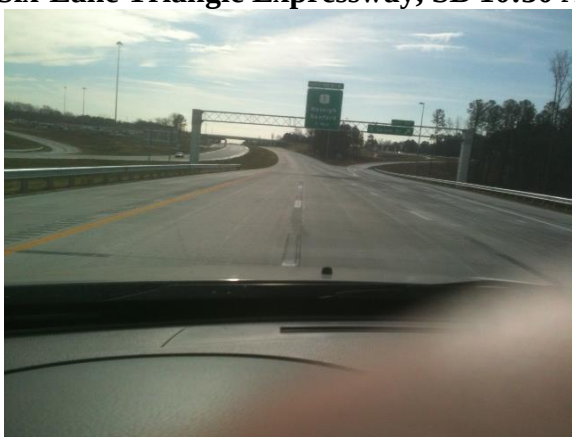
[43] R. Bain, On the reasonableness of traffic forecasts. Traffic Engineering and Control, April 5, 2011. At www.robbain.com.
[44] B.Flyvbjerg, Survival of the un-fittest. Oxford Review of Economic Policy, 25:3 2009.
[45] D Kriger, Estimating toll road revenue and demand, NCHRP Synthesis 364, Transportation Research Board, Washington DC, 2006. At www.trb.org.

12. **A possible traffic and financial failure scenario.** The above review suggests that as presently described, the I-77 HOT lanes project has a substantial risk of failure from a traffic, and possibly a revenue viewpoint. Of course no one can predict exactly what will happen if the project is built as planned. But given the uncertainty of many of the underlying assumptions, the following is a possible scenario describing the traffic failure and its impact:
    - **The HOT lanes are opened, but traffic is very low.** This is possible, even probable, since the traffic forecast is optimistic regarding economic growth in the corridor, recently opened alternative routes (i.e. I-485), traffic volumes forecasts, values of time, and diversion by other drivers.
    - **Revenues fail to meet expectations.** Based on low HOT-lane traffic volumes, commuters in general purpose lanes complain to state and local officials. Revenue fails to meet expectations.
    - **Congestion continues to build on I-77 general purpose lanes.** As time progresses, corridor traffic continues to use I-77 general purpose lanes and traffic on those lanes continues to grow and congestion increase, while traffic on the HOT Lanes levels off below forecast values.
    - **Political pressure increases.** As congestion builds on I-77 general purpose lanes but the HOT lanes appear underutilized, frustrated commuters put pressure on local and state politicians to open the HOT lanes up to general traffic, or slash tolls.
    - **Government intervention.** Eventually, seeing the huge delays in general purpose traffic alongside under-used HOT lanes, government officials step in and either open the lanes to general (possibly cars only) use, or slash tolls. This is the scenario that recently played out in Atlanta[46], where the Georgia Governor Nathan Deal stepped in to cut tolls by 40% after the HOT lane did not meet traffic expectations shortly after opening.
    - **Legal and administrative actions follow**. The Georgia case involved a state toll authority as the toll road operator, whereas the I-99 HOT lane proposal involves a third party (Cintra) as the toll road operator. Therefore, if this scenario occurred on the I-77 HOT lanes, the legal implications of this action and the resulting (if any) payments to or from the tolling organization would probably be more complicated than in the Georgia case.

13. **Conclusion.** North Carolina's only experience with toll roads, the recently opened Triangle Expressway in Wake County, is carrying traffic volumes way below the capacity of the facility. Here is a recent image of traffic flow, at that time carrying about 7000 vehicles/day on a road designed for 150,000:

[46] Atlanta Journal Constitution, "[Governor Nathan] Deal lowers tolls on I-85 HOT Lanes" October 7, 2011. Attached as Attachment 15.

Six-Lane Triangle Expressway, SB 10:30 AM, 11-24-2013



If the Triangle Expressway traffic is 'on track' as sometimes asserted, then a very large road has been built relative to a prior traffic estimate. If it is 'off track' from predicted, then the accuracy of traffic forecasting for North Carolina toll roads is in question.

It is not possible to forecast the future accurately, as the HOT lane study has done. This means that judgements must be made, but with the best information available, and the result must be reasonable and understandable. But numerous questions regarding this forecasts are raised in this Affidavit, increasing its uncertainty. This Affidavit identifies numerous examples in the traffic forecasts where the justification is questionable or unclear.

To say the least, it would be a great embarrassment to the state and the project supporters and an unnecessary government expense for a scenario like the Georgia HOT lanes opening to occur in the I-77 corridor, particularly after the vocal warnings from many quarters that the project is ill-advised as now designed. I understand the difficulty of a change in direction now for a project that has been in planning many years, and for which contracts have been signed. However, the likelihood of a significant increase in congestion in the corridor, even forecast by the project sponsors, along with under-utilized tolled lanes nearby, represents a likely imminent harm that cannot be overlooked. Prudence dictates caution, and calls for the suspension of the implementation of the I-77 Hot Lanes until a more thorough review of a wide range of less intrusive options can be made.

Thank you for this opportunity to comment on the I-77 HOT Lanes project.

This the _____ day of _____ 2015.

_____, Affiant

SWORN TO AND SUBSCRIBED BEFORE ME
THIS THE _____ DAY OF _____, 2015.

_____NOTARY PUBLIC

MY COMMISSION EXPIRES: _____