FINAL REPORT

Review of
Wake County Transit Plan

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Executive Summary

The draft Wake County Transit Plan, released in November 2011, proposes a doubling of bus service, new commuter rail[1] service between East Garner and Durham, and light rail[2] service between Cary and northeast Raleigh. The expanded service is proposed to be funded by a ½-cent sales tax, a $10 increase in vehicle registration fees, increased vehicle rental fees, transit bonds, State and Federal funds, and rider fares. The estimated cost of the expanded bus and commuter rail plan is $2.8 B, and the full Plan (including light rail) $4.6 billion through 2040.

We are in agreement with the Plan that the near-term focus of improved transit service in Wake County must be improved bus-based service. We laud the Plan's recognition of that reality. However, our primary finding is that **the Plan, as now proposed, is not technically or financially feasible and is unreliable as the basis for decisions regarding transit investment in Wake County**.

The basis for our finding is that the Plan contains numerous optimistic assumptions, errors of fact or omission, and calculations that are at variance with standard practice in the transit industry. Among our primary concerns are:

General:

- **The plan does not include funding for current transit service; it discusses only funding for expansions of service.** If added to the Plan, the needs of that service would add $2.2 billion to Plan costs.
- **Implied future ridership is over-estimated.** No baseline data on ridership or current operations are provided other than a few 'size' measures. No ridership forecast is provided for substantive justification for the proposed expenditure. The Plan does not mention the needs of the current system's primary markets: low income, no-vehicle riders in need for transitional mobility.
- **If implemented, the Plan implies an average transit vehicle occupancy of just 11% of seats, about 4.6 passengers per bus**, a 30% decrease from current occupancy**.** Commuter Rail and Light Rail would have about the same 11% occupancy, at 12.8 and 8.6 average passengers per vehicle. All are extraordinarily low by transit industry national standards. Wake County deserves better transit utilization than 11%.

[1] Commuter rail (CR) generally operates on freight rail lines from suburbs to central cities; is primarily peak period, home-to-work-and-back oriented, has an average distance between stations of approximately three to five miles and, therefore, tends to have a high speed of operations; and has average passenger trip lengths generally over 20 miles. The Long Island Rail Road and Chicago Metra are examples of commuter rail systems.

[2] The specific characteristics of Light Rail Transit (LRT) can vary, but generally include passenger rail vehicles operating in short trains, (most commonly, two to three cars) on tracks that may parallel roads, but where rubber tire vehicles cannot operate in the same lanes; which have at-grade crossings of streets where the trains, rubber tire vehicles, and pedestrians are separated by signage and signaling; generally (but not always) powered by electricity from overhead catenary wires; have stations at approximately one-mile intervals, and have speeds and carrying capacities that are lower than that of heavy rail systems (such as the New York City subway system or the Chicago "L," or Washington, DC MetroRail). The Massachusetts Bay Transportation Authority's Green Line in Boston, San Francisco Muni Metro, and Charlotte's LYNX are examples of LRT.

'Streetcar' is considered by the Federal Transit Administration (FTA) to be a subset of LRT, with the main physical differences being the sharing of traffic lanes by streetcars and rubber tire vehicles. Consequently, Streetcar operating speed is far lower, smaller vehicles are common and multiple-car trains are uncommon, there tends to be far more stops, and the routes are generally far shorter than modern light rail lines.

- **The cost per rail rider trip is extraordinarily high, $92 (FY10 dollars) for commuter rail and $33 for light rail, respectively** – or $47,000 and $16,900 per year, respectively, for each five-day a week, 52-week a year, home-to-work and back user[3]**.**
- **The total cost per rider and per passenger-mile is very high.** For the entire Plan period through FY40, the total expenditure per rider is $16.13 (FY10 dollars), which is 368% of the present $4.38 for the existing four operators. Per passenger-mile, the expenditures of the proposed new service are $2.73, 337% of the current $.81. (Transit industry national averages for 2010 were $5.19 and $.98[4], respectively.)
- **The proposed added transit service is unlikely to prove attractive to potential riders.** In our analysis of the seven "choose how you move" vignettes in the Plan, which show how current drive-only trips could be made via various types of transit if the Plan is approved and the services implemented, the transit travel times are remarkably non-competitive with driving. The overall average transit trip time was well over double that of the drive time for the same trip. Given that most of the current Wake County transit riders do not have access to automobiles for their transit trips, while the service expansion is primarily to areas where there is now little or no transit – and the vast majority of people in these areas ***do*** have access to automobiles – it is difficult to see why most people would give transit serious consideration in the new service areas.
- **Impacts are not quantified.** The Plan contains no supportable discussion of what the impact of a doubling of transit service would actually be. Its statements concerning impacts on congestion, air quality, travel time, energy, and jobs are unfounded. Most construction items are made elsewhere, construction jobs are short-lived, and taxes would slow local economic activity.
- **The proposed Commuter Rail and Light Rail services are inappropriate** for a region of this size and density. The region's density is lower than all but three of the 34 regions now operating rail transit service.
- **The Plan contains no tie to the region's long-range transportation plans,** which propose different modes and locations for transit service.

Revenue forecasts are over-estimated in some cases, under-stated in others.

- The Plan contains **optimistic population, vehicle registration and employment growth assumptions.** Employment growth for the Raleigh Central Business District (CBD) would *quintuple* present employment, equivalent to adding 2-3 Wal-Marts of office space there *every year*. Forecasts of local revenue are overly optimistic.
- **The Plan misses over $ 500 million of potential *current* federal funding.**
- The Plan's **assumptions regarding future Federal and State funding are unrealistic**. In particular, assumptions about light rail funding are too optimistic.
- **The Plan only briefly discusses other revenue sources.** Transit bonds, rental cars, State funds and rider fares are only briefly discussed.

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[3] Note that there is a long standing metric for proposed new fixed guideway transit projects of cost per ***new*** rider, which was instituted by the Federal government many decades ago in recognition that many riders of new fixed guideway systems are former transit users who are just switching to a new mode of transit. As the Plan contains no information regarding ridership, we have no way of determining cost per new rider, so these are cost per ***total*** riders. In general, for these types of new fixed guideway transit systems, it is rare for the new riders to approach 50% of total riders.

[4] Authors' calculations from national transit database, www.ntdprogram.gov "Operating Expense," "Capital Uses," and "Service" tables.

Development and operational costs are under-estimated

- **The Plan misses the need for 'spare' vehicles** and hence under-states its vehicle requirement by 20%.
- **Proposed timing of service startup is very optimistic**. The proposed expanded bus service cannot begin five months after the proposed November 2012 election and it more will more likely take more than two additional years before the first new service begins.
- **Vehicle size (40 seats) is too large** for the anticipated ridership, leaving most capacity unused.
- **Proposed Commuter Rail and Light Rail travel times for service are too optimistic** given station spacing and track alignments in comparison with existing operators.
- The Plan implies a **large increase in vehicle per-mile operating costs**. The Plan also fails to use industry standards for incremental service, which are typically only 60-70% of base service costs.
- The Plan implies a **large fare increase, about 54%,** for riders of the added bus service, which would have to be matched for current service riders.
- The Plan is **missing additional costs for ADA**-related demand-responsive service.
- The Plan is **'infrastructure heavy'**, initially spending significant funds for bus terminals and other infrastructure.

Equity, Fairness and Cooperation

- The Plan implies a **large cross-subsidy** of taxes from suburban towns to Raleigh.
- The Plan has **no discussion of permission from NCRR, CSX or NS** to use tracks.
- **The Plan has no treatment of the cost of money** (The Federal government mandates a 7% discount rate), which, if included, would lower the buying power of future revenue.
- The Plan contains **no consideration of service integration or privatization.**

In short, the Plan is a 'revenue and spending' plan for expanded service, not a transit plan.

Our review does not propose alternative approaches, which are beyond our scope. However, we recommend that the Plan be appropriately revised, including but not limited to:

- At a minimum, **the Plan should be re-done by an independent group** familiar with the transit industry and transit service in Wake Co. Obviously, unrealistic assumptions and computational errors must be corrected. As it presently exists, the Plan has a disturbing large number of errors of commission and omission of all types, from minor to huge that brings its accuracy into question.
- **The Plan *must* be placed in the context of regional transportation needs,** particularly the needs of the 90% of the region's population who are primarily auto users.
- The Plan should also be re-focused on the **needs of *transit-dependent* citizens.**
- Significant **opportunities to hold down costs,** through such actions as smaller vehicles, privatization, competitive bidding, and service integration should be fully explored.

It is hoped that this review will contribute to open and objective discussion of the Plan in Wake County. This review was funded by the John Locke Foundation. However, the authors have no other contractual or other relationships with any Wake County organizations.

Contents

I. Introduction

The **Wake County Transit Plan**[5] (referenced hereafter as the Plan) released in November 2011 proposes to substantially expand transit service in Wake County, North Carolina. Its first phase, termed the Core Plan, would more than double the comparative current bus service in five years. It would also implement Commuter Rail service on a 37-mile 12-station route using existing tracks from Garner through downtown Raleigh, then west through Cary to Research Triangle Park and West Durham. The cost of this Core Plan, about $2.8 billion over 28 years through 2040[6], is proposed to be financed largely by a ½-cent sales tax on most retail goods a $10 increase in vehicle registration fees, a rental car tax, rider fares, transit bonds, and state and federal funds. The second phase, termed the Enhanced Plan, would add Light Rail Transit service over a 13.9 mile route with 16 stations on (partially) new track from downtown Cary through downtown Raleigh extending northeast to Millbrook Road. The Enhanced Plan would cost $4.6 billion, with the light rail transit (LRT) increment being dependent upon additional Federal and State sources. Discussions of the Plan by various elected and appointed officials are expected to occur during the spring 2012, and may possibly culminate in a ballot initiative in November 2012.

If implemented, the Enhanced Transit Plan's $4.6 billion of expenditures would constitute over 30% of the $13.5 billion price-tag of the Wake County/Capital Area Metropolitan Planning Organization (CAMPO portion) Long Range Transportation Plan through 2035[7]. If we add in another $2.2 billion to continue to operate and recapitalize the current transit system, that percentage increases to over 40%[8] of the total long range transportation plan (LRTP) surface transportation spending. Yet transit use in Wake County is currently only about 1% of commuting and a lower share of all trips, and these proposed transit improvements ***will not significantly increase that share***. In fact, even if the Plan is implemented transit modal split may decrease because non-transit person trips will increase faster than transit trips.

Because of the very high proposed taxpayer expenditure and significant questions concerning the cost-effectiveness and impact of the Plan if implemented, the John Locke Foundation, an independent nonpartisan think tank based in Raleigh NC, has expressed interest in evaluating the Plan. The Foundation has asked Prof. David T. Hartgen, retired Professor of Transportation Studies at UNC Charlotte, and Thomas A. Rubin, Transportation Consultant, Oakland, CA, to review the Plan. This review is a summary of their assessment. The review evaluates the Plan with respect to its underlying demographics and regional growth forecasts, key financial assumptions, revenues and expenditures, dependence on other government actions, equity and balance, impacts on the community, and other issues. Given the limited timing and

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[5] Wake County, Wake County Transit Plan, Draft for November 14, 2011 Presentation to the Wake County Board of Commissioners, Wake County, North Carolina. Available at www.wakecounty.gov.

[6] Wake County governmental entities operate on a fiscal year that runs from July 1st to June 30th of the following calendar year, as does the Plan and the Spreadsheet. Fiscal year 2012-2013 runs from July 1, 2012 to June 30, 2013, and will hereinafter be referred to as "FY13."

[7] Capital Area Metropolitan Planning Organization and Durham-Chapel Hill-Carrboro Metropolitan Planning Organization, 2035 Long Range Transportation Plans, Version of May 20, 2009, "Figure 8.1: DCHC and CAMPO Costs," page 78. Available at www.campo-nc.org.

[8] Because the Plan includes some expenditures for expanded transit that are not comprehended in the LRTP, and we are unable to identify exactly how much, we have discounted the percentages in this sentence to avoid over-statement.

resources available for this assessment, the review does not propose a separate Plan but instead only comments on the proposed Plan. However, suggestions regarding various issues are also made.

This review uses publically available information regarding the Wake County transit systems, regional demographics and the local economy, regional transportation plans, and other generally available information to make its assessment. Additional material, primarily electronic Spreadsheets used to develop the Plan, were also kindly made available. The data, methods and other assumptions used in this review are fully documented.

A brief note on transit data sources is appropriate. Wake County is currently served by four transit operators[9]:

- Capital Area Transit (CAT**)**, a unit of the City of Raleigh, which operates motor bus and demand-responsive service.
- The Town of Cary *(*CTRAN), which operates motor bus and demand-responsive service.
- The North Carolina State University (NCSU) Transportation Department (Wolfline), which operates motor bus service.
- The Research Triangle Regional Public Transit Authority (Triangle Transit, or TT), which operates motor bus, demand responsive, and vanpool service in Durham, Orange, and Wake Counties.

We have used as our primary data source the Federal Transit Administration's National Transit Database (NTD, www.ntdprogram.gov), which is the long-standing source of uniform data for almost all US transit agencies. However, NTD collects data for each agency as a whole, and there is no way to subdivide the data by geographic area served. Because of this, we have reported, and summed, *all* Triangle Transit data as if it was operated in Wake County in the reports and discussions following. Triangle Transit also is the operator of the Durham Area Transit Authority (DATA) as a contractor for the City of Durham. However, DATA reports separately to NTD and its information is *not* included in the Triangle Transit data.

As independent consultants, Prof. Hartgen and Mr. Rubin are expected to be objective, professional and use the most recent information. They do not do 'advocate' studies for which specific answers are expected. Neither Prof. Hartgen nor Mr. Rubin is a resident of Wake County nor owns property there. Except for the current review for the John Locke Foundation, neither has any contractual relationship with any Wake County organization. This report summarizes their views only, and does not necessarily reflect the views of the John Locke Foundation or any jurisdiction or business in Wake County or North Carolina.

[9]Wake County is also currently served by Amtrak, including the State-funded Piedmont train; however, Amtrak is classified by the Federal government as "intercity rail" and, therefore, by definition, is not transit.

II. Findings

A. What is Proposed

The Wake County Transit Plan, issued in November 2011, proposes three major elements:

- **Local bus service is proposed to be more than doubled in five years** and expanded in both coverage and service density to the city of Raleigh, nearby suburbs and outlying communities. The bus plan proposes to add 130 buses to the peak bus fleets of Capital Area Transit (CAT), the City of Cary (CTRAN), and the Wake County portion of Research Triangle Regional Public Transit Authority (Triangle Transit)[10] – which totaled under 100 buses at the end of 2010 – and increase annual revenue vehicle hours[11] (RVH) from 345,000 to about 667,740 revenue vehicle hours in five years. The added vehicles and service hours and miles will lengthen existing bus lines into areas previously unserved, add entirely new bus lines, and add service to existing routes so that the intervals between buses (the "headways") will be shortened.

- **Commuter Rail (CR) service would be initiated** between East Garner (Greenfield Parkway) and West Durham, cooperatively with Durham County, operating on existing tracks. It would operate over a 37 mile route with 12 stations, 30-minute (peak) and 60-minute (off-peak) headways, and a 52 minute travel time from Garner to West Durham. This service would be initiated in FY20.

- **Light Rail Transit (LRT)** service would be initiated, partially on new right-of-way, between Cary through downtown Raleigh to Millbrook. The Plan proposes a 13.9-mile line with 16 stations and 10 min peak (20 min off-peak) headways, with a travel time of 28 minutes from Cary to NE Raleigh. The Plan shows this service commencing in FY24.

The proposed system would be developed in two phases. The first, termed the **Core Plan**, contains the proposed bus service expansion and the commuter rail service. It is proposed to be financed largely through a new ½-cent sales tax, a $10 increase in vehicle registration fees, increased rental car taxes, transit bonds, and rider fares. Additional support from State and federal sources is also expected. Total expenditures (capital and operating) are estimated at $2.8 billion through 2040. The second phase termed the **Enhanced Plan** adds the LRT service, funded largely by state and federal funds. Total expenditures for the Enhanced Plan are estimated at about $4.6 billion through 2040 (not including estimated cost of $2.2 billion for operating/capitalizing existing bus, demand-responsive and vanpool services, $6.7 billion with those costs included.)

[10] The fourth Wake County transit operator, Wolfline, operated by the North Carolina State University Transportation Department, does not appear to be programmed for any direct funding from the measures proposed in the *Wake County Transit Plan*, and the 345,000 annual bus revenue service hours, from page 15 of the Plan, appears to be the total for the three named transit agencies above; therefore, unless specifically stated otherwise, statements in this document do not include Wolfline service.

[11] A 'revenue vehicle hour' is a standard measure of service provision in the transit industry. It represents the service hours that vehicles are available for serving riders, but omits 'deadheading' to and from garages and out-of-service time.

What the Plan is ***not***:

- The Plan is actually not a 'transit' plan, but is rather just a transit *revenue and spending* plan, and for only the proposed expansion, not the current services. A comprehensive transit plan would put the proposal into regional context, review existing services and their adequacies, forecast ridership and demographics, and look at other related services such as carpooling and vanpooling, ADA and DSS services. There would also be a specific tie to the region's transportation plan that covers all modes, most specifically the automotive travel that will account for well over 90% of all passenger transportation for the foreseeable future, and freight movements, both truck and rail, including insuring that the proposed passenger rail lines will not interfere with rail freight movements.

- The Plan is not a 'comprehensive transportation plan'. The region's transportation planning organization, CAMPO[12], periodically issues a comprehensive long-range transportation plan for the area, considering transit, highways and other modes. The latest long-range plan issued in 2009 has somewhat different treatment of transit services, and therefore would have to be revised to be consistent with this Plan.

- A particularly large missing element is any discussion of the current vanpool system, in terms of passenger-miles about 15% of the current bus passenger-miles. Yet, there is no mention of it in the Plan and no apparent funding for it, even though it is now the most cost-effective transit service operated in the region.

- The Plan also does not discuss, other than in very general terms, what the impact of the Plan would be on ridership or passenger-miles, peak period or overall modal shares of travel, improvements for transit-dependent persons, impacts on congestion, impacts on regional travel times, environmental impacts, and revenue and expenditure equity between either the four existing transit services in Wake County or between the jurisdictions within Wake County.

- The Plan argues that the community needs 'choices' for traveling. Perhaps, but one can argue that many choices – living and working locations, modes, time of day for traveling, etc. – already exist for most travelers. Government does not 'owe' us a 25-minute commute; we already 'choose' our commutes and other travel patterns as part of our living and working decisions. The fundamental issue raised here but not answered is whether $4.6 billion of taxpayer dollars should be spent for 'choices' that less than 1% of Wake County travelers will use.

In short, the Plan addresses only the *additions* to transit service that would be added from the new taxes, but does not provide substantive information as to what those additions will accomplish.

B. Regional Growth and Demographics

- **The Plan's population growth forecast is optimistic.** The Plan notes that during the last decade Wake County grew by about 43% (about 3.7% annual growth rate), among the

[12] Capital Area Metropolitan Planning Organization, website www.campo-nc.org.

fastest growing urban regions in the nation and over four times the national average. The Plan forecasts a 2040 future population of Wake County of 1.67 million persons, about 85% higher than in 2010 (901,000), implying a slower future annual growth rate of 2.1%. Table 1 summarizes the Plan's forecast. This growth rate is more than twice the historical national average, and is likely three times the future national growth rate. Projected annual growth rates for smaller suburban towns are even higher, up to 6.6% annually for Knightdale and 6.2% annually for Rolesville. Even for Raleigh, the projected growth rate over the next 30 years is 1.5% annually.

Table 1: Population Forecasts in the Plan[13]

Jurisdiction	2000 Pop, K, Census	2010 Pop, K, Census	Annual Growth Rate, 2000-10	2040 Pop, K Forecast	Annual Growth Rate, 2010-40
Knightdale	6.0	11.4	6.7	78.1	**6.6**
Rolesville	0.9	3.8	15.4	22.9	**6.2**
Wendell	4.2	5.8	3.2	34.0	**6.0**
Zebulon	4.0	4.4	0.9	24.3	**5.8**
Fuquay-Varina	7.9	17.9	8.5	78.4	**5.0**
Garner	17.8	25.7	3.8	104.2	**4.8**
Apex	20.2	37.5	6.4	114.2	**3.8**
Wake Forest	12.6	29.2	8.8	74.8	**3.2**
Holly Springs	9.2	24.7	10.4	59.0	**3.0**
Raleigh	276.1	402.8	3.8	624.9	**1.5**
Morrisville	5.2	18.6	13.6	28.7	**1.5**
Cary	94.5	133.8	3.5	196.5	**1.3**
Total Above	**458.7**	**715.7**	**4.5**	**1,440.0**	**2.4**
Rest of Wake County	**169.2**	**185.3**	**0.9**	**227.8**	**0.7**
Total Wake County	**627.8**	**901.0**	**3.7**	**1,667.8**	**2.1**

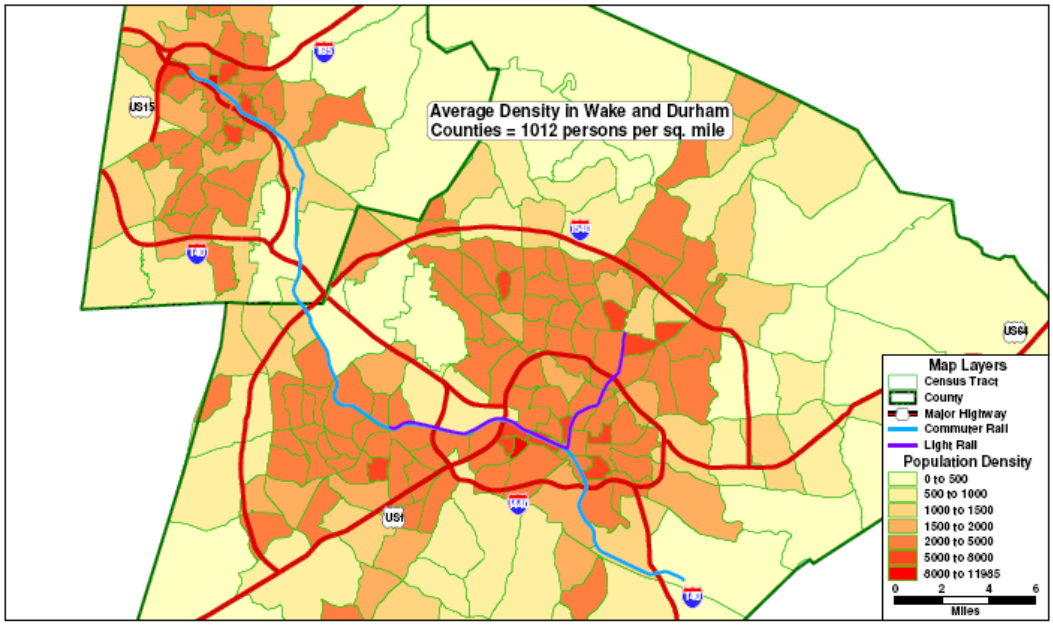
This growth forecast strains credulity. Wake County region has certainly been a rapidly-growing area compared to other US regions, but recently its growth rate has slowed considerably. The projections of the State Demographer suggest continued growth of 3.4% in 2011 but slowing to 2.7% in 2012. But in 2011 new housing starts in Wake County were only about 4,000 units, implying a growth rate of less than 1%[14]; it is highly unlikely that even with the relative attractiveness of the region, the Wake County growth rate for the next 30 years would be twice this rate, and 3-4 times the national average.

But even if true the projected growth will be largely in the ***near and outer suburban areas*** of the County, but much less in the present transit service area. In 2010 Raleigh contained about 45% of the county population, but the Plan forecasts that share will fall to 37% by 2040. In other words, the region will be growing fastest in precisely the areas not presently served by transit and not likely to have high transit use rates in the future.

[13] Plan, p. 9.
[14] Metrostudy News, "Triangle market inventory and starts improve during 3Q11", Metro-study News, Nov.7, 2011.

- **Residential densities are likely to remain lower than needed to support rail transit.** But even with growth, the densities of residences along the proposed CR and LRT lines will be insufficient for fixed route transit service. Most studies of this issue note that residential densities need to be in the range of 4,000-6,000 persons per square mile for 'good bus service' and considerably higher, 8,000-15,000, for CR or LRT service.[15] This is because about 80-90% of Wake County transit riders currently board or leave the system by *walking*[16], so there needs to be enough population living or working close to the lines to make the service effective. Figure 1 shows the current residential densities for the tracts along the LRT and CR lines. Mostly, they are in the range of 1,500-5,000 persons per square mile, with only a few tracts over 5,000, and only two over 8,000 (one in Raleigh, one in Durham). Most of the tracts through which the proposed CR goes are much lower in density. The overall density of the Raleigh urbanized area[17] is about 2,150 persons per square mile; it would be the fourth lowest of the 34 cities in the US that now have LRT/CR/Streetcar service (See Appendix).

Figure 1: Population Densities of Wake and Durham County, 2010.



[15] Transportation Research Board, Driving and the Built Environment, Special Report 298, 2009; and G. Arrington and R. Cervero, Effects of TOD on Housing, Parking and Transit Use, TCRP Report 128, Transportation Research Board,, Table 1.9, 2006. Based on initial studies by B. Pushkarev and J. Zupan, Where Transit Works, Regional Plan Association, 1977. Primary references at www.trb.org .

[16] HDR Engineering, 2010 Capital Area Bus Transit Rider Survey, Tech. Memo # 1, Memorandum to CAMPO, September 22, 2011.

[17] Urbanized areas are created, and defined, by the Census Bureau: "An urbanized area (UA) consists of densely settled territory that contains 50,000 or more people. A UA may contain both place and non-place territory. The U.S. Census Bureau delineates UAs to provide a better separation of urban and rural territory, population, and housing in the vicinity of large places." ("Geographic Terms and Concepts," http://www.census.gov/geo/www/tiger/glossry2.html#UR). UZA's are not defined by political boundaries, such as city or county lines, may include multiple political units, and may cross state lines. The key criterion is density of population.

So even with the projected growth, most of the region's tract densities are likely to be only 2,000-3000 persons per square mile at most, too low to support effective CR or LRT service.

- **Employment center growth is optimistic**. Another optimistic forecast is the projected employment growth for major transit hubs. The Plan forecasts that Raleigh CBD employment will *quintuple* from 14,600 in 2010 to 79,010 by 2040; that downtown Cary and Garner will triple in employment; and that RTP employment will double[18]. For the Raleigh CBD, this would mean an increase of about 64,400 workers, requiring an additional 13 million square feet, larger than that of present-day Charlotte's CBD. This means adding roughly 450,000 square feet of office space, about 2-3 large Wal-Mart stores, to downtown *every year*. No plans of that magnitude are currently being discussed. The State work force is not likely to triple in size. The Legislature is cutting back university growth rates, and in Research Triangle Park the whole high-tech/bio-tech industry is flat in employment.
- **Economic impacts on the regional economy are likely to be small.** Economic impacts of transportation projects depend largely on the benefits that users receive (savings in travel time, accidents, and operating costs), NOT on 'construction jobs' or 'indirect jobs'[19]. Construction jobs are short-lived, most construction material and vehicles are not manufactured locally, and the local taxes reduce buying power. The rail rider volumes forecast here, even if believed, are probably too small to affect even localized economic activity.

In short, the magnitude and locations of likely growth and the demographics of local major transit markets suggest that the region's primary transit markets will grow considerably less rapidly than projected in the Plan.

C. Ridership and Impacts

- **Transit ridership is not actually estimated in the Plan.** Transportation and transit planning traditionally begin with estimation of demand for services and end with forecasts of what the ridership on the planned transportation improvements will be. The Plan does not estimate either present or future ridership, with the exception of some passenger-mile projections in the details of the Spreadsheet; but these are assumptions rather than projections based on data and analysis. In short there is no quantification of transit use. This omission means that the Wake County Transit Plan is not a transit plan; it is a spending plan.

- **Present Wake County transit modal shares are about 1% of workers and less than 1% for non-work trips.** Data from the Census and the American Community Surveys[20] (Table 2) indicates that the share of public transit commuting in Wake County was about 1.2% of workers in 2000 but has declined since then, even though in absolute terms it has

[18] Plan, page 20.
[19] FTA's economic impact of public transit investment is estimated at 30 job-years per $ 1 million in average spending, including indirect and induced jobs. Source: Weisbrod G and Reno A, Economic Impact of Public Transportation Investment, TCRP Project J-1, Task 7, 2009. But others estimate much less impact.
[20]Sources: 2000: Census Journey to Work; 2005 & 2010: American Community Survey. At http://www.census.gov/

registered a small gain. About 4,626 workers in Wake County regularly use public transit to commute. This is about the same volume, for example, as the morning peak-hour traffic on Wade Avenue. Carpooling shares have also dropped sharply, by about 1/4, since 2000. The most rapidly growing commute method is actually 'work at home', the share of which has almost doubled since 2000 with little government assistance. Mode shares are not expected to change significantly in the future (See Appendix).

Table 2: Wake County Travel, Mode-to-Work, 2000-2010

Mode to Work	2000 Census	2000 Percent	2005 ACS	2005 Percent	2010 ACS	2010 Percent
Drove Alone	274,674	81.1	309,045	81.5	359,221	81.5
Carpooled	37,823	11.2	38,821	10.2	37,898	8.6
Public Transportation-Taxi	**4,153**	**1.2**	**3,102**	**0.8**	**4,626**	**1.0**
Walk-Bike-Motorcycle-Other	9,215	2.7	9,086	2.4	11,626	2.7
Worked at Home	12,737	3.8	19,259	5.1	27,582	6.3
Total Workers 16+	**338,600**	**100.0**	**379,313**	**100.0**	**440,953**	**100.0**
Mean travel time, all commuters (min)	**24.7**		**23.8**		**23.9**	
Mean travel time, transit (min)	**39.6**					

- **Need for mobility determines transit use**. It is not 'population growth' but the need for mobility that determines the need for public transportation. As with most transit systems, transit riders on the Wake County transit systems are predominately persons needing mobility assistance for relatively short duration. Table 3 prepared from the County's recent on-board rider survey[21] indicates that the *ridership of CAT and CTRAN is largely no-auto-available, minority, low-income, and not elderly. About 73% of CAT riders have income less than $25,000/year*. TTA riders have a somewhat higher average income, more vehicles-available, and are split evenly by race, but are also frequent and recent riders. Wolfline riders are primarily students with low income but high use rates.

Table 3: Transit Rider Profiles, Wake County (Percents), 2010

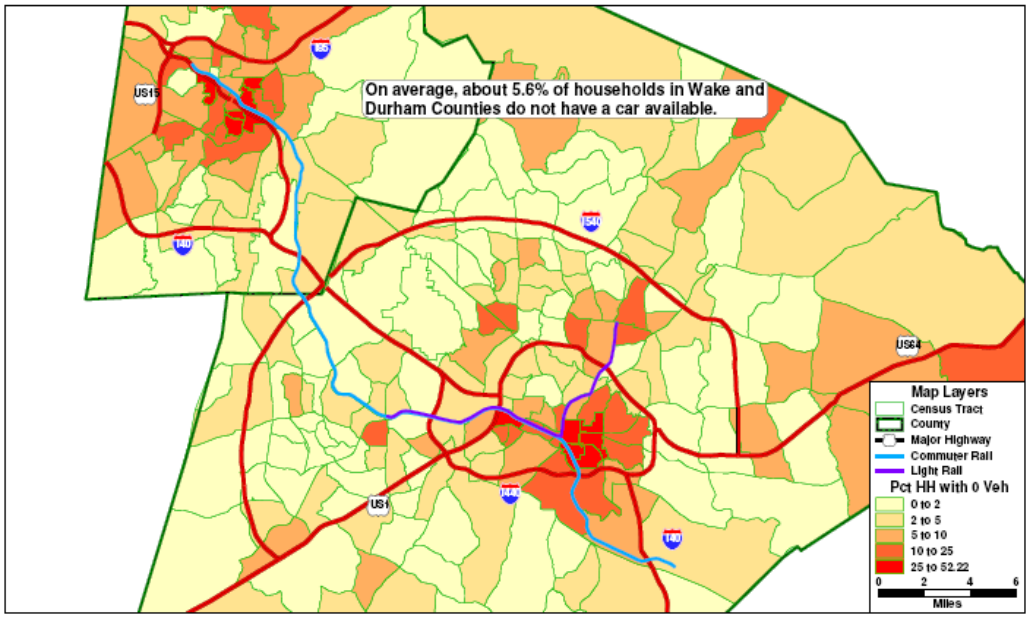
Statistic	Raleigh CAT	Cary CTran	Triangle Transit Authority	NCSU Wolfline
Auto Own/Avail				
No Vehicle Own/Avail	**54**	**42**	**22**	**NA**
Income				
<$10K	35	23	17	65
$10K - $25K	38	35	21	21
(total pct < $25K)	***73***	***58***	***38***	***86***
$25K-$50K	21	40	25	8
>$50K	6	12	37	6
Gender				
Male	45	50	55	52
Female	55	50	45	48
Age				
< 25	28	28	25	79
25-65	70	68	73	21
> 65	2	4	2	0
Trip Purpose				
Work	29	52	40	7

[21] HDR, Rider Survey, op. cit.

Education	8	2	15	60
Shopping	7	11	1	0
Other	56	35	44	33
Race				
White/Caucasian	23	36	53	80
Minority	**77**	**64**	**47**	**20**
Riding Duration				
First time rider	**3**	**8**	**4**	**3**
< 1 year	**23**	**37**	**34**	**43**
1-2 years	**21**	**31**	**25**	**30**
3-4 years	16	15	19	20
> 4 years	37	9	18	4
Riding Frequency				
<=2 days/week	13	24	15	12
3-4 days per week	15	21	24	20
>5 days a week	**72**	**55**	**61**	**68**
Access Mode				
Pct Walk, Boarding	87	74	64	81
Pct Walk, Leaving	90	78	76	90

Figures 2 and 3 indicate how the proposed CR and LRT routes line up with tract demographics. Only a few tracts in the region have greater than 25% zero-vehicle households (the primary transit market), and only even fewer are adjacent to the proposed rail routes. Most tracts near or on the proposed CR and LRT lines have a lower percentage of zero-vehicle households. Further, although zero-vehicle households are expected to increase slightly from 27,000 to 32,000 in 2030[22], the projected growth of the region will be faster than that, so the *no-vehicle household share will actually fall (good for region, bad for transit ridership).*

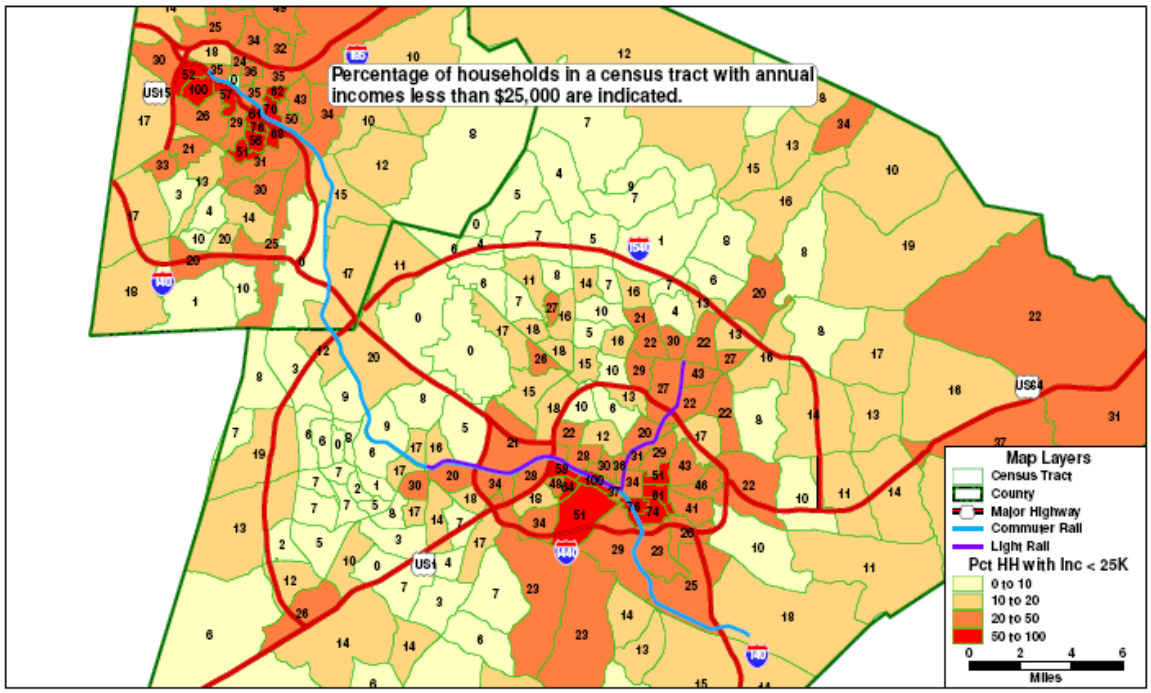
Figure 2: Percent of Households with No Vehicle Available, 2010



[22] 2035 LTRP, 2009, op. cit.

The match-up for income is also not good. Only a handful of tracts in the region have greater than 50% of households with low incomes (< $25k), and even fewer are adjacent to the proposed rail routes. The Plan's assumption that areas within *one mile* of stations are likely zones for use is probably a significant over-statement, since traditional transit planning limits most walk-up ridership to a ½-mile radius of the station[23]. Most of the tracts near the proposed CR and LRT stations have considerably higher incomes. And, given the generally rising income picture for the region, the percentage of residents in these tracts is likely to rise in the future, boding poorly for expected growth of a key transit market.

Figure 3: Percent of Households with Income Less Than $25,000, 2010

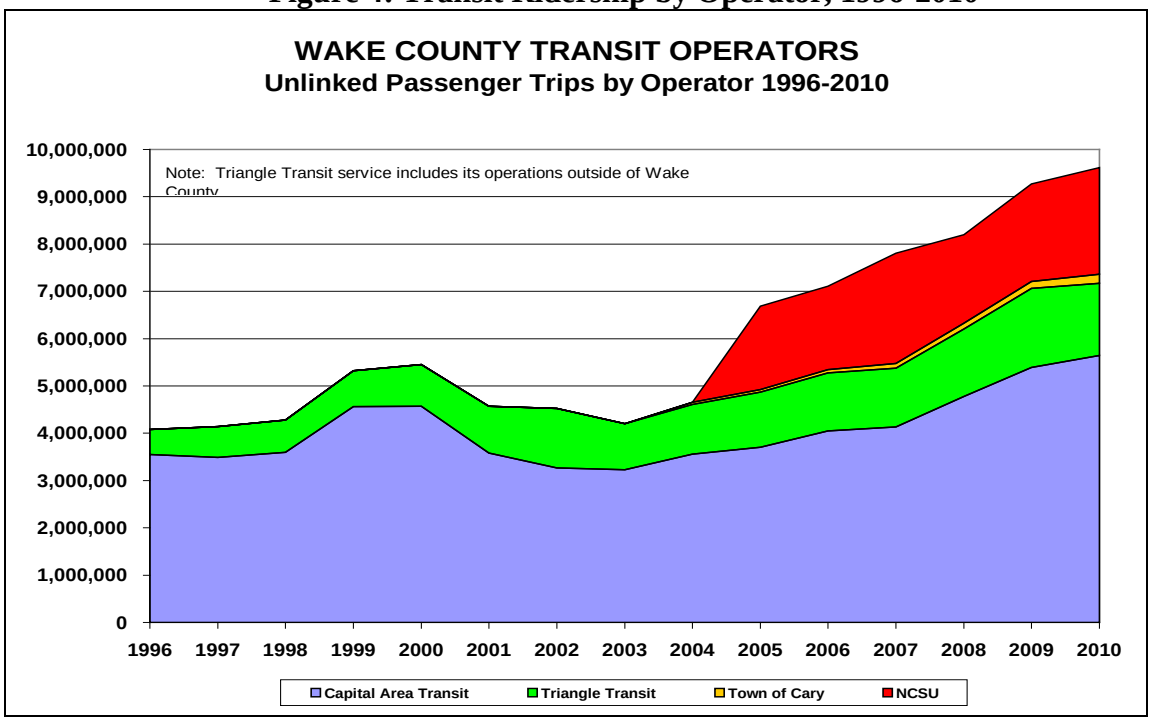


- **Transit use is mostly short-term duration**. Table 3 also shows that although transit riding frequency is quite high among current riders, it is also *short-lived*. Most riders have been riding less than two years. This considerable 'churn' in ridership suggests that riders use transit primarily for interim mobility needs, as a 'steppingstone' to more convenient services, or when between job or school circumstances. Indeed, the on-board survey also noted that the top two reasons for using transit were '[it's] my only option' and 'save money'[24]. The Plan however is silent about the critical need for the service by these transit-dependent riders.

[23] TRB, Special Report 298, op. cit.
[24] HDR, Rider survey, op. cit., p. 24.

- **Ridership will NOT double if the Plan is enacted.** According to the Plan Spreadsheet the four systems now carry about 9.62 million annual trips[25] (Figure 4). This is a substantial increase from 2000, when the systems carried about 5.45 million trips. But much of the growth was due to the NC State University system adding about 2.2 million annual trips since 2006. Cary's CTRAN system added about 190,000 trips. Growth of the CAT system usage during the past decade was 23.4%, about ½ the rate of Wake County population growth. So, as noted above, CAT transit use is growing slower than the region itself. TTA usage during the decade grew about 74%.

Figure 4: Transit Ridership by Operator, 1996-2010

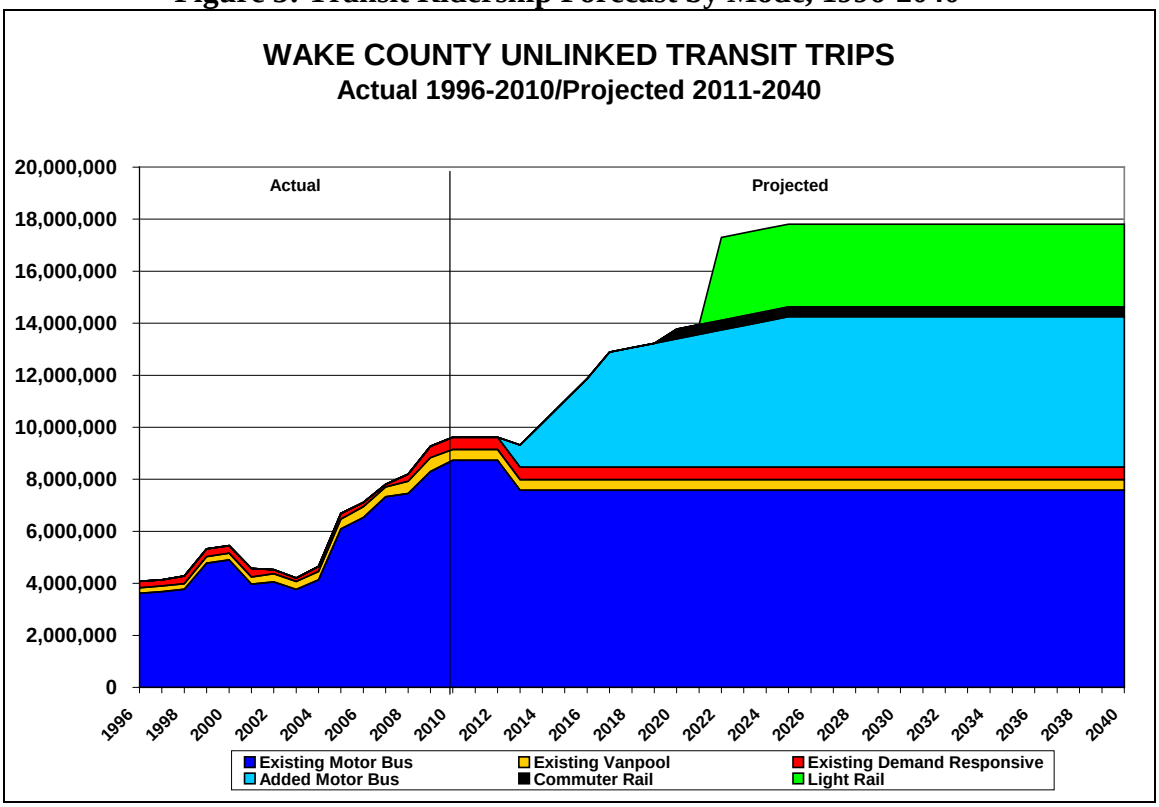


The Plan itself contains no forecast of transit ridership, but using the data in the supporting Spreadsheet[26] the transit ridership is implied to almost double by 2040. Figure 5 shows the implied increases, by mode.

[25] The 'unlinked trip' is the standard measure of transit use. It is a one-way trip between a single origin and destination, NOT including transfers. So if a transit rider uses bus to go to and from work but transfers from one route to another on the way, that would be four separate 'unlinked trips' per workday. See Appendix for more detail.

[26] Farebox ratios and other statistics are used to estimate future ridership that the Plan implies. See Appendix.

Figure 5: Transit Ridership Forecast by Mode, 1996-2040[27]



But a doubling of transit service does NOT generally produce a doubling of ridership. Typically, a 10% increase in service produces just a 5% (about half that amount) increase in ridership[28]. So if service were to double, as proposed in the Plan, the ridership would increase by only about 50%, to perhaps 14.5 million trips. And since total regional travel by all modes is predicted to increase even faster, by about 85%[29] (in parallel with population), the transit share of regional travel would likely *decline*.

- **Transit travel time will not be faster than driving.** The Plan implies that commuting via transit will be faster than driving[30]. This is incorrect for three reasons. First, the average commute times in Wake County are already *declining* as the region spreads out and more jobs and residence are in the suburbs. In 2000 the average Wake County work

[27] Note the decline in bus ridership on existing service in 2013-14 when the added bus service begins. This is due to the 54% fare increase that will be necessary to produce the 15% farebox recovery ratio assumed in the Plan. When this is applied to the existing bus service (except for NCSU, which does not charge by the ride), at the Simpson-Curtin -0.33 fare elasticity, there is a predicted drop in ridership of approximately 1.2 million unlinked passenger trips per year. See more detailed description in the Appendix.

[28] This concept is termed 'elasticity' in economics literature. It refers to the percentage change in a statistic caused by a 1% change in another statistic. Fare elasticities are typically -0.33, and service elasticities +0.5. Source: R. Pratt, Traveler Response to Transportation system Changes, TCRP Report 95, 2003, p. 9.5. At www.trb.org.

[29] CAMPO Long Range Plan, 2009, Air Quality Conformity Document. The LTRP itself estimates that regional travel will about double between 2005 and 2035. Source: E. Johnson, CAMPO private correspondence, Jan.10, 2012.

[30] Plan, page 9, "While no transit system can relieve a highly populated area of traffic problems, it can give commuters more choices about how to get places, ***and gives them options that save travel time*** (emphasis added)."

commute time (door to door, all modes of travel) was about 24.7 minutes but by 2010 this had declined to 23.9 minutes (see above Table 2). Second, the travel times mentioned in the Plan[31] are in-vehicle times only, and do *NOT* include home-to-station, parking, walking, waiting for service, or walking to destinations. These elements typically increase transit time for the total trip by 40-60%, making transit trips longer than drive alone trips, even with congestion. Table 2 (above) indicates that door-to-door travel times for Raleigh-area transit riders are about 60% longer than the County's average. These delays also limit demand to trips with at least one destination within walking distance. Third, the Plan's estimates of in-train travel time are not likely to be achieved, because the stated commuter rail and light rail travel speeds are significantly above industry norms, particularly after considerations of the specific details of the alignments[32]. The Plan further implies that transit has more reliable travel times because it avoids road congestion. That would only potentially be the case for the CR and LRT systems which are a small part of the ridership increase; buses are generally subject to road congestion.

- **Transit service increases will not materially reduce congestion**. The Plan implies that increased transit service will reduce congestion[33]. Actually, congestion growth in the Raleigh-Durham region is *already moderating* and is unlikely to increase sharply. The annual statistics from the Texas Transportation Institute[34] shown in Table 4 indicate a flattening of congestion growth, and in any case the worst congestion is limited to just a few major corridors that are already planned for road work. Even if the CR and LRT transit services could run faster than cars, their small share of commuting means that their effect on regional travel times would not be measurable.

Table 4: Congestion Indices for Raleigh-Durham

Year	Travel Time Index*	Rank
1982	1.04	
1999	1.12	
2008	1.13	
2009	**1.13**	**44th highest**
2009 Ave Large Cities	1.17	

*ratio of travel time in peak to travel time in off-peak.

- **Improved transit service will not significantly reduce congestion delay**. The most recent *Mobility Report* indicates that at present, public transportation in Raleigh-Durham is estimated to save about 3.5% of regional congestion delay[35]; but that assumes that all peak period-transit riders were former solo drivers, they leave cars at home and that none of those cars are driven elsewhere. However, since only 46% of CAT riders have vehicles

[31] Plan, page 19.
[32] The stated travel time for the Commuter Rail, 52 minutes for 37 miles, implies an average 'running time' of about 47 minutes, assuming 10 intermediate stops of 30 seconds each. This would put the average running time (37 miles in 47 minutes) at about 47 mph, high for CR averages, and implying top speeds between stations of 60-70 mph. (Source: ITE, Transportation Planning Handbook, 1992, fig. 5.1). A similar argument holds for the LRT proposal. This is discussed extensively in the Appendix.
[33] Plan, page 11.
[34] D. Shrank et al, *2010 Mobility Report*, Texas Transportation Institute, College Station Texas, December 2010. At www.mobility.tamu.edu .
[35] D. Shank et. al, *op. cit.*, Tables 2 and 3.

available (see Table 3 above), the impact of the current transit commuting on congestion would be, at maximum, about 1.5% of commuting delay. This is consistent with the journey-to-work figures, in Table 2, indicating that only about 1% of Wake County commuters use transit. So, increasing transit ridership by about 50% would probably reduce regional congestion delay by about 0.75%, too small to be noticeable. The reduction would be even smaller in the I-40 corridor which has a lower share of transit use.

- **Road improvements will hold congestion largely in check.** The CAMPO 2035 Long Range Transportation Plan contains some 300 roadway projects, of which about 60 have been deemed as "regionally significant" (Figure 6). Generally these projects involve improvements along the major commuter routes, which include Interstates and numbered U.S. Highway routes, key state highways, and the principal arterials providing interregional movement. Projects are categorized by anticipated date of completion, with the 2040+ projects not being part of the fiscally constrained Plan.

  Between now and 2030 several large road projects are likely to significantly improve road congestion in the CR and LRT corridors, and therefore reduce the competitiveness of both the commuter rail and the light rail systems. Key projects are noted in Table 5. Examples are the planned HOT Lanes for I-40 and the Toll Road extending the Durham Freeway. All of these projects add lanes or capacity to existing major roads.

Figure 6: Wake County Regionally Significant Highway Projects

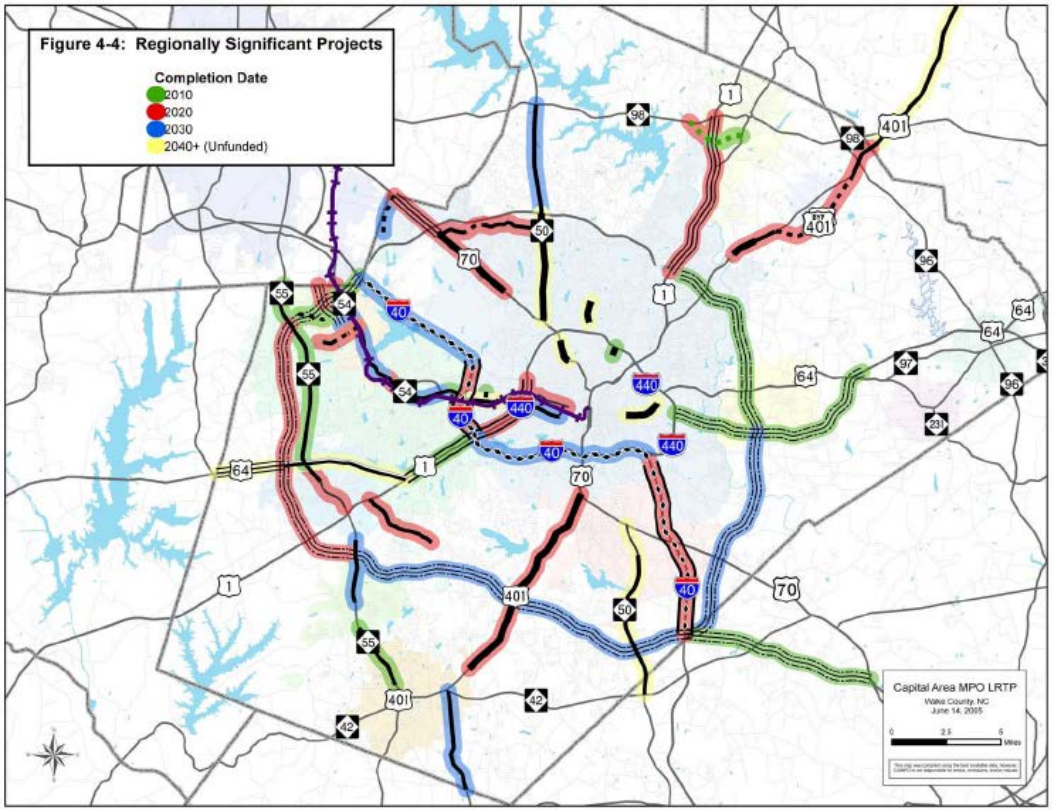


Table 5. Regionally Significant Highway Projects with Costs over $100 M

Facility Name	Length (miles)	Lanes Added	Completion Year	Cost ($M)
I-40 HOV/HOT Project-Added Lanes	26.5	0	2030	$268
I-40 (South) Widening	10.7	4	2020	$217
I-540 (Eastern Wake Expressway)	12.9	6	2030	$151
I-540 (Southern Wake Expressway)	16.5	6	2030	$256
I-540 (Western Wake Expressway)	12.4	6	2020	$262
US 1 (Upgrade to Freeway)	8.8	2	2020	$188
US 64 West Conversion to Expressway	8.9	2	2040	$197
US 70 (Clayton) Bypass	9.5	4	2010	$135
Triangle Parkway	5.1	4 or 6	2030	$111

The effect of these projects on congestion will be significant. The CAMPO 2035 Plan predicts that with these projects, travel time indices (speed ratios) on urban Interstates will increase only slightly, from 1.11 in 2015 to 1.13 in 2035[36] – in other words, a trip that takes 20 minutes off-peak can currently be expected to take 22.2 minutes during the peak period, and 22.6 minutes during the peak in 2035, an increase of 24 seconds, or a rate of increase in congestion equal to slightly over one second a year. Therefore, it is likely that the planned road improvements for the region will allow congestion to be held largely in check.

[36] CAMPO, Conformity Report, op. cit, tables on speeds by functional class.

There is no historical record of an increase in transit usage decreasing traffic congestion nor of decreases in transit usage increasing congestion. There are examples, notably in Portland, Oregon, of shift of priorities and funding from roads to transit actually *increasing* congestion, even as transit usage increases[37]. Given the very low transit mode-to-work share in Wake County, both currently and as contemplated in the Plan, a representation that significant spending to improve transit service will have any noticeable impact on traffic congestion is unfounded.

- **No 'reduced need' for roads is likely**. There is *n*o evidence that the proposed changes in transit use would eliminate the need for even one lane, let alone several lanes, on any regional road. The forecast transit ridership, which is likely overstated, is too small and is not geographically concentrated enough to affect any road's traffic.

- **Air quality will improve sharply regardless of Plan implementation.** The Plan suggests that diversion of car drivers to transit can save air pollution[38]. That would only be the case if new transit riders were prior solo drivers and those vehicles were not then driven by others, both unlikely. But the *vast majority of air quality improvements in the region will be caused not by mode shifts but by reductions in vehicle emissions.* Table 6 from the region's air quality conformity plan[39] indicates that Wake County will *reduce* emissions of nitrous oxides (NOx) by about 50% between 2015 and 2035, *even though* traffic will increase 40%. Carbon monoxide (CO) emissions will also be held in check. This assessment does not even contain the latest round of Obama Administration fuel efficiency mandates, which would make vehicles even cleaner. Therefore, the air quality of the region will continue to improve sharply. Doubling transit use would add, at most, about 0.5% to the improvement, too small to be measurable. Transit's impact is small because transit use is less than 1% of regional travel, so even doubling it would have no measurable effect on local air quality. For the same reason transit's impact on water quality is likely to be minimal.

Table 6: Wake County VMT and Air Quality Forecasts

Year	Daily VMT, million	% Change from 2015				
		VMT	NOx	NOx, if Transit Doubles	CO	CO, if Transit Doubles
2015	33.7					
2017	35.5	5.2	-18.8			
2025	42.7	26.5	-46.7	-47.2	0.6	-0.4
2035	**47.2**	**40.0**	**-50.3**	**-50.8**	**5.0**	**3.9**

Further, transit buses at best are currently approximately equal to automobiles in energy utilization per passenger-mile and carbon dioxide (CO_2) production[40]. And since

[37] Thomas A. Rubin, *Transit Utilization and Traffic Congestion – Is There a Connection?* (Currently in pre-publication review, Reason Foundation). Will be available at www.reason.org, 2012.
[38] Plan, page 11.
[39] CAMPO Conformity Report, op. cit., and Capital Area Metropolitan Planning Organization, 2035 Long Range Transportation Plan Amendment, Appendix J.
[40] S Davis et al. National Transportation Energy Data Book, Ed 30, 2011, Table 2.13. Cars 3538 btu's/pass-mile, bus 4242 btu's/pass-mile.

the average transit passenger loads in Wake County are so low, and the projected average passenger loads for new bus service are far under the current load factors, a strong argument can be made that increasing bus transit utilization will have a *negative* impact on energy usage and emissions. The low CR and LRT average passenger loads, well under national averages – strongly suggest similar results negative air quality results from the proposed rail projects.

- **Economic development will be largely unaffected by improved transit**. The Plan suggests that regional economic development is dependent on good transit service. But most job growth and economic activity in this region, as in most regions, has been in suburban environments with limited transit access. It just is not the case that "*people tend to flock toward transportation centers*", as the Plan argues. Transportation access is a key factor for businesses, but the percent of employees *within 30 minutes by car* is the major factor. Transit access has a much lower percent of employees within 30 minutes than car access. In Raleigh, even if some employment growth occurs in the CBD, such as Red Hat, there is likely to be a future loss of jobs as a percentage of the regional total, in part due to suburban jobs becoming more accessible and growing faster than CBD jobs.

- **The elderly use primarily private cars and friends/family, not transit, for mobility.** As the Rider Survey (Table 3 above) shows, only 2% of Wake county transit users are elderly. Most elderly use private cars and family and friends for their mobility needs. Those disabled are also eligible for paratransit services. Very few elderly use conventional transit for their mobility needs.

- **The Plan has minimal discussion of inter-county commuting**. The Plan contains little discussion of inter-county transit commuting: only the list of commuter rail stations in Durham County and Triangle Transit expenditures and fares, which likely include some service in other counties – but no quantification of actual ridership. There is also no discussion of inter-county *car* commuting, which will be a higher share of travel in the future[41].

- **Expanded bus service will require expanded ADA service.** The Federal regulations implementing Americans with Disabilities Act (ADA) require that fixed route transit operators, such as the Wake County bus operators, provide "comparable" (such as times of day and days of week service is operated) demand-responsive service for the eligible transportation disadvantaged within three-quarters of a mile of fixed route bus lines and, that such service also be operated within three-quarters of a mile of rail transit stations[42]. The Raleigh area Human Services Transportation Plan recognizes this requirement[43]. Triangle Transit and Cary's CTRAN also provide demand responsive ADA service.

[41] Hartgen DT, Traffic Congestion in North Carolina, Report for the John Locke Foundation, March 7, 2007, page 29. At www.johnlocke.org.

[42] 49 CFR 37.131, "Service criteria for complementary paratransit," (a)(1)(i) for bus and (a)(2) for rail: http://www.fta.dot.gov/12876_3906.html

[43] CAMPO and the City of Raleigh Coordinated Public Transportation – Human Services Transportation Plan, prepared by the Triangle Transit Authority, February 2008, available at: http://www.ncdot.gov/nctransit/download/Plans/CapitalAreaMPO.pdf

Since the Plan proposes extending fixed route bus and rail service to areas of Wake County not currently served by transit, it appears that the ADA demand-responsive service area of Wake County will also be increasing. But there is no mention of, or financial provision for, this in the Plan. There is no specific mention of how the Plan, fixed route bus and rail service expansions will impact ADA demand-responsive service expansion[44], or an estimation of what the capital and operating costs of this additional ADA service may be.

D. Financial Analysis

Sources of Funding

- **The Plan does not include continuing expenses for *current* transit service**. The Plan as written proposes a spending plan for *expanded* transit services, but does not include continuing costs for operating the current services. Operating and capital costs for these services, all modes (after deducting 60% of Triangle Transit's costs, our assumption of what should be allocated to non-Wake County service) totaled about $46 million in 2010[45]. Over the period 2011-2040 we estimate that this continuing cost would be about $2.2 billion. This large additional expenditure is not discussed in the Plan.

- **Forecasts of economic activity growth rates seem high**. Projecting past trends for economic growth may be convenient, but the recent changes in the economy suggest that both real growth and inflation will continue to be low in the future. This assessment also appears to ignore sales tax leakage to other counties, which is more likely if Wake grows fastest near its edges.

- **Transit expenditure growth assumptions appear to be high.** Growth rates for future expenditures in the Plan and Spreadsheet, which are assumed to track inflation (1.5% annual inflation through FY15, 3.1% annually thereafter[46]), seem to be high considering the flatness of wages now, and likely modest inflation. As discussed below, significant growth in the scope of transit operations is a great opportunity to reduce the cost per unit of service provided to the public, such as cost per vehicle revenue mile, but the Plan basically assumes that current costs will not change, in constant dollars, over the entire Plan period through FY40.

- **Revenue from the ½-cent sales tax seems optimistic**. For the reasons discussed above regarding population growth, the growth of sales tax revenue at 2.5%/year after FY14[47] seems optimistic. The forecast also does not allow for future economic slow-downs, a near certainty.

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[44] Plan, page 31, "ADA Flexible Routes," for a discussion of how "fixed route" services are proposed for route variation to handle ADA requests. This can be a cost-effective tool in certain Wake County situations, but it is unlikely that this alone could satisfy all ADA requirements, as extensive off-route operations will make the bus service schedules unreliable for those who are using for non-route-variation service.

[45] Federal Transit Administration, National Transit Database, 2010 statistics for the four operators.

[46] Spreadsheet, "Assumption Summary" tab, rows 120-128.

[47] Plan, p. 32-33.

- **Vehicle registration growth rate appears high.** The assumed vehicle registration growth rate, 2%/year, appears high since many studies think vehicle registration is approaching saturation. If population growth slows, registration growth will also slow.

  Further, past history of imposition of vehicle registration fees in one political jurisdiction, while fees in other nearby jurisdictions have not increased, suggests that vehicles owners may decide to seek out means of registering their vehicles in lower fee areas. The extreme case is the City of Seattle Monorail vehicle registration fee of 1.4% of vehicle value, where the revenues were 30% below expectations[48], which was generally attributed, in part, to the ease in which Seattle residents could register their vehicles at the outside-of-Seattle addresses of friends and relatives. The proposed Wake County fee is a small fraction of the Seattle fee, and is not likely to increase significantly the propensity of Wake County residents to seek out innovative tax reduction strategies. But at a minimum, it should be expected that commercial enterprises with multiple locations within the State will likely consider registering their vehicles in jurisdictions with lower registration fees if a reasonable business justification is available.

- **Rental vehicle fees are not discussed.** The proposed vehicle rental tax is assumed to generate $121 million. This is not discussed, but is about 2/3 of the proposed vehicle tax increase. Rental car fees are often attractive targets, but some are paid by residents, not visitors.

- **Significant funds needed to 'buy existing services' are not explained.** The Plan notes[49] that TTA proposes to use $3.50 of the additional $10 vehicle registration fee to "*buy existing services to outlying areas currently being provided by CAT and CTRAN*". As the above is the total explanation for this usage in the entire Plan, it is unclear exactly what is intended, but our best guess is that it will allow jurisdictions other than the Cities of Raleigh and Cary to stop existing payments to CAT and CTRAN for present service in their jurisdictions. This would allow residents in these localities to see their total County tax payments reduced, while the residents of all other jurisdictions will be paying more.

  But why are taxpayers paying one government agency to 'buy' service from another? Wouldn't the current operating agency just stop the service, or the current source of funding for these transit services just remain in place?

  This raises an interesting question – if the residents of some political jurisdictions will see their existing taxes used to pay for transit services being reduced because the new taxes are substituting for the previous sources, wouldn't the residents of the other areas that currently paying local taxes for transit services – and their elected representatives –demand the same treatment?

  This "buy(ing) of existing services," what it is, what it is intended to do, and what is proposed, needs a clear explanation.

- **Federal fund reimbursements for bus service per vehicle-mile are over-stated, but total federal bus service reimbursements are under-stated.** The Plan's Spreadsheet calculates values used to determine future Federal grant funding by inflating a value from four years prior, rather than obtaining the correct value from the Federal Transit

[48] eNotes, "Seattle Monorail Project: http://www.enotes.com/topic/Seattle_Monorail_Project.
[49] Plan, "Vehicle Registrations," page 33.

Administration (FTA) or the FTA website. In addition, the four-year-old value is incorrect. Therefore the Spreadsheet utilizes an incorrect value for each revenue mile operated. This over-states the likely federal reimbursement by about 8%. See Appendix.

Although it is clear from the details in the Spreadsheet that those who constructed it understood that the basic calculation is *vehicle revenue miles x value per vehicle revenue mile*, and the Spreadsheet was actually set up to make that calculation, an alternative methodology was utilized – which produced over-statement of revenues earned in the early years and under-statement in the out years, with a total *under-statement* of over $35 million through FY40.

- **Federal-formula funding for Commuter Rail service is significantly under-stated.** The Plan Spreadsheet does not appear to recognize that *the bus service grant program also applies to rail operations.* Federal service reimbursement funds generated by the proposed commuter rail service would be far higher than that generated by the bus service, *approximately $323 million through FY40*. (an unknown portion, but probably approximately half of the proposed commuter rail line, would be in Durham County[50] and, therefore, approximately that portion of the Federal funding generated would appear to 'belong' to Durham County, assuming that the commuter rail service is operated under some type of shared responsibility agreement.)

- **Potential federal support for Commuter Rail from the Fixed Guideway Modernization program appears to have been overlooked.** The preparers of the Plan and Spreadsheet also appear to have not been aware of the FTA Fixed Guideway Modernization program, which would appear to generate over *$60 million in previously unanticipated funding through FY40* (again, likely shared approximately equally with Durham County).

- **Federal formula support for Light Rail also appears to have been under-stated.** Similarly, there is no indication that the Plan's *light rail service* would also be eligible for another $51 million of FTA Formula grants and over $120 million in Fixed Guideway Modernization grants through FY40. See Appendix.

- **The Plan's total under-statement of potential federal funding support is over $500 million.** This brings the grand total of under-statement of Federal grant funding that could be anticipated by the level of service that the Plan proposes (with the major qualification that the current Federal transit grant programs continue as they currently exist, which is almost certainly not to be the case) to over $500 million (including commuter rail-generated funding that would likely be applicable to Durham County).

- **Free parking is assumed.** The Plan does not include parking revenues in its assessment, suggesting that parking at CR and LRT stations will be free. This is a large cross-subsidy to CR and LRT users from taxpayers and parking lot/garage operators, and at the least a loss of revenues. This also implies that one of the chief benefits for rail transit users will

[50] Plan, page 4, shows the Wake County share of the total capital cost of the commuter rail line as $330 million and the Durham County share as $320 million out of total cost of $650 million, or a 50.8%:49.2% split.

be free parking at transit stations, instead of having to pay for parking at some destinations. Of course, this advantage would only apply to those whose employers do not provide free parking – unless there are plans to limit, prohibit, or tax employer or retailer-subsidized parking.

- **Revenue needs are probably under-stated.** By the Plan's own admission, the money being discussed is not enough to finish the job. LRT is said to need federal and state support that the region "*will compete for but cannot count on*". So, if that doesn't pan out, there might be another round of local revenue-raising required.

- **The Plan has a strange mixture of over-estimation of certain Federal and other revenue sources and under-estimation, or even omission, of others.** For example, the Plan has bus operations beginning a few months after the expected November 2012 election, with the additional Federal "formula" funding being received that same year, when, in fact, it will likely be five years before such funding is received. But other types of Federal formula funding that would actually generate far more revenue in the "out" years of the Plan do not even appear to have included. Some may say, this indicates fiscal prudence, providing a safety factor. However, given that there is currently very real question of what the future Federal transit program will look like, with it being almost impossible to come up with a reasonable scenario that current levels of funding will exist into the future, it is not difficult to opine that a more sophisticated approach is required, While the Plan does discuss that the Expanded Plan will require gaining competitive grants, and their uncertainty, the base assumption for funding existing service is, "*some federal and state grants currently help fund local bus services; we expect that to continue*[51]" – which most experienced transit industry and Washington observers would likely say is far from a certainty, at least at the current levels.

  We believe a more prudent approach would be to have experienced, knowledgeable transportation experts prepare a plan that is fully cognizant of all potential sources of funding, and their risks, as well as how expenditure plans can be changed by various factors, and develop a more robust transportation capital/operations/financial plan, including transit consumption (ridership) and realistic benefit-cost comparisons, including quantification of the various risk factors and uncertainties, rather than presenting a plan to the voters for their action that contains clear errors and internal inconsistencies.

Implementation and Start-Up

- **Start-up timing of expanded bus service is highly optimistic.** It is common for proponents of a new tax to want to be able to show the voters that the new tax is producing visible results as soon as possible. The Plan describes an extremely fast start-up of new services – if the proposed new transit taxes are approved by the voters on November 6, 2012, buses will be ordered, manufactured, delivered, paid for, and placed into operation on April 1, 2013 – and this will generate Federal grant funds to be received in the same fiscal year to help pay for the purchase of the buses. There is no explanation

[51] Plan, "A Practical Approach: Bus and Commuter Rail," page 3; "The Recommended Core Transit Plan – How We Will Pay for It," page 4: "The Recommended Enhanced Transit Plan – How We Will Pay for It," page 5;

of how bus service can begin April 1, 2013, when there is clearly not sufficient time to procure, have manufactured and receive buses and have them ready for service.

In the real world, it will likely take until approximately *July 1, 2015 before the first new transit services can begin* – and the Federal grant funds that this will generate will likely not be received until early calendar year 2017. This is discussed extensively in our Appendix. This inconsistency between the Plan's assumptions and the 'real world' of transit planning raises serious concerns about many other assumptions.

- **Other similar services might be reduced.** With the exception of the Triangle Transit, the new taxes appear to be intended to be used for transit system *expansion*[52] (and certain other infrastructure improvements, such as streets and sidewalks, which are presented as supporting transit improvements[53]). The Plan implies by inference that *existing transit service* would be continued. However, given the extreme difficulties that all local governmental units are experiencing in balancing their budgets, particularly with reductions in Federal and State grant funding, it is not difficult to envision that the leadership of the cites that operate transit in Wake County may be interested in using the new dedicated transit taxes as a means of reducing existing levels of "general fund" transit subsidies. We assume that there will be prohibitions against such actions written into a tax referendum presented to the voters, but we caution that ways around such restrictions can sometimes be found.

- **Parking lots and buildings are a high portion of initial spending.** The Plan notes[54] a very large and expensive infrastructure program, particularly park-and-ride lots (and other transit infrastructure like sidewalks) – $226.7 M, all in the first three years, which is about twice what is proposed to be spent on new buses. For 2010, the total taxpayer subsidies for transit, all modes, by all four operators, was $40 M, so the Plan proposes to spend 5.5 times that to improve its infrastructure, with only a relatively small portion of that (such as the new operating yard) actually having a direct connection to carrying passengers. Eminent domain powers might be needed to undertake this initiative.

- **The Plan makes major capital investments for 'transit centers', some of which are in areas which have no transit service now.** The Plan includes transit center expansion and construction of new ones in Apex, Cary Station (expansion), Crabtree Valley, Crossroads, Moore Square (expansion), North Carolina State University, RTP, and Wake Med[55]; transfer point expansion and construction in Avent Ferry and Gorman, Cameron Village, Duke/Raleigh Medical, Fuquay-Varina, Garner, Holly Springs, Morrisville, New Hope and New Bern, Rolesville, Sanderford and Rock Quarry, Wake Forest, Wendell, Wilmington Street, and Zebulon[56]; and park-and-ride lots expansion and new construction at Capital and Burlington Mills, Greenfield Parkway, Hillsborough and I-40, Knightdale, NC 540 and NC 55, Regency Park, Wake Tech Main Campus, and Wendell

[52] Plan, "Revenue and Expenditure Summary for the Core and Enhanced Transit Plans," page 39.
[53] Plan, "Improving Streets, Stops, and Sidewalks," page 31, and Appendix A, page 41.
[54] Plan, p. 41.
[55] Plan, p. 42.
[56] Plan, p. 43.

Falls[57]. Considering that the $227 million to pay for these facilities (including a new bus operating facility) are shown as occurring in FY13-FY15, they are actually far more, in constant dollars, than the $257 million in bus expansion and replacement of buses that have reached the ends of their useful lives through FY40[58]. (The long-standing financial concept of 'present value' holds that a dollar today is worth more than a dollar in the future and, the further out into the future, the less that future dollar is worth).

We understand the logic of the proponents of the Plan in these expenditures. One of the classic issues in funding transit, particularly major transit systems expansions such as this, is getting funding from suburban and rural areas to fund a program where the vast majority of the consumption of the new services will be in the urban centers, with a very fast fall off of benefits as distance increases from those centers. In this case, the City of Raleigh and its residents are likely to be the major beneficiaries, with Cary and a few other urban centers also benefiting, while the residents of the entire county are being asked to share the same individual tax burdens of sales tax and vehicle registration fee increases for far lower levels of benefits, or even none at all in many cases. The classic response to this issue is to show the residents of the non-urban centers that, yes, indeed, you will receive benefits. In the Plan, communities such as Fuquay-Varina, Holly Springs, and Rolesville – which do not currently have transit service[59] – not only get bus routes, but new transit centers.

But as we point out below, the average utilization of the expanded bus service will be extremely low, far lower than even current usage, which is well below national averages. And service to the farther out, lower-populated and less densely populated areas will be even lower than the already low average for the added service, so low, in fact, that one questions if, after a reasonable period, the only rational decision that those responsible for the productive use of taxpayer funds to make is to cancel some of this new service.

To avoid this likely scenario, there should first be a professional evaluation of the potential demand for the services that are proposed and, where appropriate, the initiation of the service. However, this should be accompanied by service standards, such as, bus lines must maintain a specified level of utilization to be continued – with a specific set of actions predetermined if these standards are not set, including attempts to increase utilization, reductions in service, and, if the standards are still not satisfied, elimination of the service, and elimination of supporting taxes.

In short, while an initial response may be to commit to construct and operate dedicated transit centers before the service begins, the appropriate transportation and taxpayer fund utilization response might be to wait until there is a demonstration that the service is successful and that transit center expansions are wise uses of public funds, prior to approving terminal construction.

[57] Plan, p. 43.
[58] Spreadsheet, "Combined Transit Summary" tab, rows 143 and 157, respectively.
[59] Plan, p. 14.

Operation

- **The need for spare buses (the 'spare ratio') appears to have been omitted.** In order to operate a given number of transit vehicles in service at the peak hour, the fleet must include a substantial number of additional vehicles, termed 'spares'. The Federal Transit Administration has established 20% bus spare ratio as a general requirement. So, if 100 buses are needed to operate peak service, a *total fleet of 120* is needed. This apparent error reduces the amount of service that the Plan proposes to operate by a minimum of 20%, or alternatively increases likely costs by 20%.

  If accounted for, this would reduce the service that can be operated or substantially increase costs. If we assume a 25% spare ratio for the added service (which is actually significantly less than the current actual for the four Wake County bus operators), purchasing an additional 43 buses would cost $63.4 million (in 2011 dollars).

- **Average occupancy on all three modes of service in the Plan, bus, commuter rail, and light rail, is very low, with all three coming in at average vehicles loads of 11% of the number of seats. Table 7** below summarizes the performance of the proposed Wake County service expansion against the 2010 national transit industry averages and number of seats in a typical vehicle.

Table 7: Wake County Transit Plan Proposed Service Expansion – Average Occupancies

Mode	Wake County Average Vehicle Passenger Load	2010 U.S. National Transit Average Passenger Load	Wake County as Percentage of 2010 National Average	Typical Number of Seats in Transit Vehicle	Wake County Average as Percentage of Typical Seats
Motor Bus	4.6	10.7	43%	40	11%
Light Rail	8.6	23.7	36%	75	11%
Commuter Rail	12.8	34.2	37%	113	11%

For the three Wake County bus transit operators where bus service is proposed to be expanded (CAT, CTRAN, and TTA overall FY10 average passenger load was 6.5, or about 61% of the national average for that year. While it is not at all unusual for transit operators in communities such as Raleigh and Wake County, which are obviously not as well suited for transit utilization as larger, denser communities such as New York City, Chicago, or San Francisco, to have utilization lower than the national averages that are dominated by these large urbanized area transit operators, it is certainly troubling to see that the expanded bus service is expected to have utilization only 70% of the current utilization, and for all three modes projected for major expansion to have utilization that is projected – *by the proponents* – to have such very low expectations.

This certainly raises the basic question, is there sufficient market for transit service to justify a major and costly expansion, or would the taxes to pay for this be better utilized for other public sector purposes – or left with the taxpayers to use as they see fit?

- **The Plan implies, perhaps inadvertently, that bus fares will be 54% higher than current fares.** One reason for low occupancy, based on detailed data in the Spreadsheet

appears to be that, in order to maintain a 15% farebox recovery ratio (the 2010 national average for bus transit was 26.6%), fare levels for new service will be approximately 54% higher, after adjustment for inflation, than those for existing bus service, which evidently reduces demand for the new services. Because the proposed added services are to be so closely interrelated to the existing services, in order to implement an after-inflation 54% increase in fares for the added service, the fares for existing services would have to be increased identically when the new service begins (scheduled for April 1, 2013 in the Plan, but below, we question whether this will be possible).

- **Commuter Rail and Light Rail operating speeds appear to have been significantly over-stated.** The Plan has distances and vehicle travel times for its proposed commuter and light rail services that translate to average operating speeds of 42.6 and 29.8 mph, respectively, which are significantly higher than the norms for these types of service, with the light rail speed significantly higher than any comparable light rail line in North America[60]. If station 'dwell time' (the time between the transit vehicle coming to a stop at the station and the vehicle starting to pull away from the station – about 20 seconds per station for light rail, generally slightly longer for commuter rail) is removed, then the implied speeds are even higher. We do not have access to the data that would be required to do detailed modeling of these speeds, but we note various factors of the proposed route alignments, including the light rail line having more station stops than industry average, which add significant concerns regarding the possibility of these speeds being achieved. It is likely that the actual speeds would be much lower than what the Plan now suggests.

  The first impact of this correction would be lower ridership, because slower speeds of travel are not as attractive to riders. Further, depending upon the actual speed that is possible, it may be necessary to procure additional trainsets (the slower the speed of travel, the larger then number of trains needed to be in service to maintain a given time between trains for a route of the same length) to maintain the specified headways, which would increase capital and operating costs and subsidies – or the lower ridership may mean that the headways can be extended, but, in turn, could lead to even lower ridership as travel becomes less convenient for potential transit riders.

  To some extent, speed of travel for a CR or LRT line is a function of what you are willing to pay for; for example, the discussion of the light rail line alignment in Appendix F of the Plan has several elevated structures. Unfortunately, there is only so much that can be done to speed up a light rail line and, in the end, the speed is far more dependent on the slower portions of the trip – particularly station stops and slower portions of right-of-way – than on the higher speed portions.

- **Operating costs per revenue vehicle hour appear high.** The Plan shows an operating cost per hour for expanded service of $85 per revenue vehicle hour in FY11[61], escalating at a 1.5% annual rate from FY11 through FY15[62]. However, the actual average operating cost per hour in FY10 was $77.91 for CAT, $96.92 for Triangle Transit, and $56.28 for CTRAN, with a weighted average of $81.64. Adding 1.5% produces an $82.87/hour

[60] National Transit Database, 2010, "Service" Table.
[61] Plan, "Expanded Bus Service and Infrastructure," page 35; Spreadsheet, "Bus Services – Unallocated" tab, cell J35.
[62] Spreadsheet, "Assumption Summary" tab, cells H127-P127.

weighted average for FY11, so there appears to be a 2.5% over-statement from this factor.

However, we find it unusual that the Plan assumes that the average operating cost/hour for *expansion of service* does not show a significant *reduction* in operating cost/hour. One would assume that those proposing service expansion would take appropriate logical and well-proven steps to make this happen, including, but not limited to:

- Basic cost accounting and micro-economics will lead to the cost of marginal hours of service added being less than the previous average cost. First, there are several types of costs that will increase little, or not at all, as service expands. For example, the costs of the Board of Directors, the CEO, and many other activities will likely not increase at all, or will increase far less than the rate of increase in service. Also, almost all transit bargaining unit contracts have salary progressions, such as starting at 70% of the "top rate" for new bus operators and increasing 5% every six months of service until 100% is reached[63]. Many contracts have lower top rate salary scales for new hires than more senior employees, so adding new service should result in engaging new employees at significantly lower rates than existing employees, particularly in the early years of each level of added service[64].
- Simple logic would have, where possible, service added by the agency with the lowest cost of service first: CTRAN before CAT, and CAT before TT.
- The agencies should attempt to make maximum use of part-time operators, which work for perhaps three-four hours/day – during the morning or afternoon peak periods – sometimes with lower hourly rates and generally with employer benefits that are far less costly than those for full-time employees.
- Service can also be contracted out to private sector transit service contractors, which are frequently significantly lower in costs than government-operated transit service. Alternatively, transit agencies could "compete" for service between private sector contractors and in-house teams, with the bargaining unit agreeing to look at changes in hourly rates, employee benefits, and/or work rules to be more competitive; San Diego Metropolitan Transit System has been particularly successful in such competitions[65].

Bus operating expenses are the largest line item in the financial plan, at $1.43 B. We believe that bringing in this 20% lower for the expanded service would be very readily possible.

- **Bus farebox recovery ratio is likely over-stated.** The Plan makes the assumption[66] that the farebox will recover 15% of the expanded bus service's operating costs. For 2010,

[63] CAT's arrangement with the Local ATU 1328 driver's union determines progression within pay ranges. Source: D Eatman to Liz San Jose, Jan. 26, 2012.

[64] Since North Carolina law generally prohibits public employee unions, transit systems sometimes contract with private operators to actually operate service with a private unionized labor force. For instance, CAT service is actually operated by Veolia, an international firm based in France with a large US contract operation based in Illinois, and CAT drivers who work for Veolia are unionized.

[65] Jonathan Richmond, *The Private Provision of Public Transport*, Harvard University, 2001.

[66] Plan, p. 37.

CAT farebox ratio was 15.2%, TTA was 13.0%, Cary CTRAN was 4.8%, and NCSU was zero[67] (beginning in FY09, NSCU evidently determined that student transit 'fees' collected at the beginning of each semester would no longer be classified as fare revenue). When service is added, the overall farebox recovery ratio generally goes *down* because it takes some time for people to learn about the new service, try it, and change what are often long-established travel patterns. If this is decent service, after a year or two the farebox ratio will generally increase as ridership increases, but based on transit industry experience it is simply not realistic to say that the overall farebox recovery for the new service will start out higher than the current overall system average – particularly this added service, which simply does not appear very competitive with driving, as discussed below.

- **Mixed operation (freight and passenger operation) poses safety and speed issues.** The Plan suggests that CR operation will be over existing NCRR and private train tracks[68] which carry freight traffic. Operating passenger service on freight routes is usually a problem since both are slowed. Safety issues are also a question. Mixing freight and passenger service on a rail route is generally not a good idea for safety and travel time reasons, even if the railroads were to provide access. Any such proposed usage would also be subject to the approvals of Federal agencies, particularly in regard to safety and non-interruption of freight service to existing shippers.

  Some of these problems may be reduced by providing additional tracks**.** The present proposed CR route is largely one-track between Durham and Cary, two-track between Cary and Oberlin Rd (Raleigh), three-or-four-tracks between Oberlin Rd and the Amtrak Station, and then largely one-track from Raleigh to Greenfield Parkway. The Plan allocates almost $302 million[69] for track improvements. This means that substantial upgrading of the current corridor, with requisite access permission and costs, would probably be needed before safe service could be ensured.

E. Equity and Balance

- **Revenues and expenditures are not in balance.** The Plan's Revenue and Expenditure Table[70] shows *that revenues exceed costs by $684 million for the Core Plan*. The Plan seems to be 'banking' front-end tax revenue to fund later service that may not be implemented, given the need for Federal and State governments to contribute. In other words, the revenue stream appears to be both optimistic and unnecessary in the first 6-10 years of the Plan.

- **Suburb-to-city cross-subsidy is likely.** In discussing revenues versus expenditures, the Plan suggests[71] but does not state that services would be returned to jurisdictions in proportion to collection of revenues. This might 'overload' service to suburban towns which are supposed to have rapid growth but might not have much demand for transit. The Plan does not show revenues or expenditures by jurisdiction or operator, but

[67] NTD 2010, Profiles for the four operators.
[68] Plan, p. 19.
[69] Plan, Prof services $84 M, right-of-way $32 M, rail special conditions $7 M, track and guideways $179 million.
[70] Plan, p. 38.
[71] Plan, p. 31.

if revenues are roughly proportional to population (actually they are likely to be tilted towards higher-wealth jurisdictions), then about 65-70% of revenues would come from outside Raleigh, yet, it is unlikely that 65-70% of service additions will be outside Raleigh. This amounts to a significant cross-subsidy from the suburban jurisdictions and rural County residents to the city of Raleigh, and to a lesser extent to Cary and Garner.

- **Expenditures are not specified by operator.** The Plan does not indicate how much funding would be allocated to each transit operator (CAT, TTA, NCSU, CTRAN), or how such allocation would be determined. Therefore the potential for mis-allocation based on service or ridership is substantial.

F. Cooperation

- **Federal involvement is unlikely at the level proposed.** First, at the project-specific level, the Plan fails to mention a key event in the history of local transit, the May 2006 letter by the North Carolina's two Senators indicating that the region's then-proposed LRT Plan would probably not pass federal muster, and the subsequent dropping of that plan[72]. That LRT proposal, different from the current LRT proposal, would have operated a 28-mile LRT (not commuter rail) service between Raleigh and Durham-Chapel Hill and serve just 7100 riders daily, at a cost of $810 million. The current Plan seems to revive a portion of that proposal (service between Raleigh and Durham) *but changes the mode of service between Raleigh and Durham from Light Rail to Commuter Rail.* The current Plan mentions the potential for later federal rejection of the now-proposed LRT line as a 'show stopper' for the line, since funding for LRT is said to require both Federal and State funds. We believe that given the operating statistics for the proposed LRT line and declining Federal funds, as well as increasing competition from other cities, *the likelihood is high that the feds would not fund the proposed LRT*. Therefore, the Plan seems to imply that future change in Federal funding policy, or perhaps changes in control of Congress, would be needed in order to pursue the LRT proposal.

- **Federal approval of LRT service is not likely to be immediate**. The assumption that the proposed light rail project will speed through the FTA and Congressional approval process so quickly that major activities such as real estate acquisition will begin in the year starting on July 1, 2014[73] – less than 20 months after the voters are assumed to approve the new transit taxes – and the commuter rail project to reach similar status one year later[74] is, to say the least, extremely questionable.

- **Future Federal funding for major expansions is in doubt.** However, even more basic questions concern *the future* of the Federal transit grant program. All Federal transit grant funds are the product of legislation, which, since the first Federal transit grant program established by the *Urban Mass Transportation Act of 1964*, has required reauthorization by Congress every five to six years. In each reauthorization since then, existing grant programs have been changed, new ones have been added, and funding levels have varied up and down. The most recent version of the surface transportation reauthorization act,

[72] B. Siceloff, Triangle rail bid to take new path, Raleigh News and Observer, August 19, 2006.
[73] Spreadsheet, "Rail Project – DtCary to Millbk" tab, cell N16.
[74] Spreadsheet, "Rail Project – TMC to Garner" tab, cell O15.

the Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users (SAFETEA-LU), was signed into law on August 10, 2005 – almost two years after its predecessor act expired – and itself expired on September 30, 2009. Congress has not been able to agree on the terms of the successor to SAFETEA-LU in over four years of effort, so, in the absence of a new reauthorization act, the terms of SAFETEA-LU have been temporarily extended a number of times – and are likely to be so again.

Trying to speculate what the new reauthorization measure may contain, or when it may pass, is most difficult. Most likely, there will be many changes to various existing transportation grant programs, so any projection of revenues that may be received from such grants is subject to considerable uncertainty. The general methodology utilized in the preparation of the Plan appears to be to assume that the *status quo of Federal funds* will continue. This is highly unlikely to be proven correct, but the utilization of other specific scenarios for a point estimates is at least as difficult to justify.

Experienced observers of the Washington scene see no reason to expect any permanent new Act to pass until after the 2012 election – if then[75]. The general consensus appears to be:

(a) If the Democrats retain the Presidency and regain control of the House of Representatives, transit funding is likely to be at least maintained, and could possibly be expanded.

(b) If the Republicans win the Presidency and/or control of the Senate while maintaining their control of the House, there will be a significant possibility of major reductions in transit funding programs.

(c) If the current situation continues, then there is a strong possibility that the current deadlock will also continue, with the likelihood that, at some point, a compromise Act with a interesting combination of key points from both sides could emerge, if for no other reason so that Congress can move on to other matters.

We will leave it to readers to supply their own best projections of the outcome of the November 2012 election. In the meantime, we caution that any plan based on the assumption that current levels of Federal funding for transit grants will continue may prove problematic. In our view it is not likely that Congress will clarify this uncertainty before the November 2012 election, when the Wake County voters may be asked to approve the new taxes to fund the Plan.

- **State money is needed for the Core Plan**. The Plan states[76] that the Core proposal would be funded by *local funds* only, yet later (p. 38) it says the Core Plan requires $289 million from the *State*. Given the State's current fiscal situation and political control, this seems unlikely. The Plan seems to be hoping for a change in political control that would increase this possibility. The Plan also assumes the State would pay 10% of rail operating costs, which does not seem likely given the current State budget situation.

- **Federal money is also needed for the Core Plan**. The Plan further states that no Federal funds would be needed for bus system expansion "*beyond what is already provided for busing*", but the revenue Spreadsheet assumes that the feds and the State will together

[75] For example, K. Orski, "Six US Transportation Secretaries Speak Up, Innovation Briefs," January 26, 2012. at www.innobriefs.org.
[76] Plan, p. 5 and p. 38.

pay for 75% of expansion. In fact, much of the funding for the bus system expansion – $242 million in Federal funding – is from grant programs that are not specified in the Plan, but would evidently come, at least principally, from the 49 USC 5309 "Bus" discretionary program. While this would appear to meet the above definition of "… *already provided for busing*," this is an extremely large sum from this source, particularly the $113.3 M, almost $38 M/year, over the first three year period, FY13-15.

- **Federal and State funding will be needed for the Enhanced Plan.** For future LRT service the Plan assumes that "*additional federal and state funds [are] provided for new start rail projects*", 50% from federal and 25% from State sources. "New Start" money is very competitive, the feds have already rejected Raleigh's earlier LRT plan, and the Congress is targeting transit for cuts, not increases. And even if it is assumed that the "New Starts" program will continue and to have funding at some level roughly comparable to the current one, there is a very long list of other cities that have their projects in line for approval, well in front of any new proposal that may come out of Wake County, and many of these have very well-placed Congressional representatives. Given the current climate, the chance of Raleigh getting "New Start" federal funds is viewed as unlikely, and additional State money is probably also questionable.

- **No service integration or transit agency cooperation is mentioned**. The Plan says it requires cooperation among governments but strangely it does not propose to integrate or coordinate the four present separate services, and does not say how the services would be integrated if at all.

- **North Carolina Railroad (NCRR), CSX, and Norfolk Southern (NS) involvement is not discussed.** The Plan seems to assume that the Legislature and/or Governor will just direct the NCRR to provide access to their tracks for Commuter Rail and possibly LRT service. Although the NCRR is a private state-owned company fully owned by the State, it has its own Board of Directors and management team[77]. In any case, it cannot be just 'directed' to permit track access for a locality's service needs. The need for access to present CSX or NS tracks is also not discussed and is also problematical since these are private corporations.

[77] North Carolina Railroad history, at www.ncrr.com

III. Recommendations

Perhaps the most positive aspect of the Plan is its recognition that public transit in Wake County must, first and foremost, start with improved and cost-effective bus service for both current markets and new markets. We applaud the Plan's recognition of this reality.

However, our review of the Wake County Transit Plan, in its totality, has found numerous issues regarding its assumptions and forecasts. The primary issues are:

- Optimistic population, economic and sales tax growth rates.
- Optimistic assumptions about the timing of service improvements.
- Optimistic assumptions about ridership growth.
- Overlooking major additional current sources of federal support.
- Optimistic assumptions about the likelihood of future federal or State support.
- Optimistic assumptions about service travel times and operating speeds.
- Unsubstantiated assessments of service impacts.
- Unlikely assumptions about operations statistics and cost of incremental service.
- Lack of treatment of equity, balance, and cooperation.
- Multiple errors of computation and best practice, leading to unreliable estimates of key cost and revenue statistics.

The above, taken as a whole, constitutes such a large and varied list of deficiencies, that we conclude that **the Wake County Transit Plan, as it now exists, contains numerous significant errors and questionable assumptions.**

These considerations, particularly not including several major existing federal grant programs, raise significant issues regarding the accuracy of the Plan and Spreadsheet in regard to basic transit industry knowledge and standards of performance for preparation of financial plans. Combined with the other errors and assumptions in other technical areas, these concerns are so numerous and important in their implications, that **in our view, the Plan is not technically or financially feasible in its present form, and is unreliable as the basis for decisions regarding transit service in Wake County.**

Therefore, we suggest the following:

- **The entire Plan should be given a detailed review by an independent and unbiased third party** with the requisite technical skills and knowledge of the transit industry and its capital, operating, and financial components, as well as knowledge of the local region. Such a review will likely produce extensive changes at all levels, from policy to programs and projects to implementation details and timing.

- **The Plan should be made part of and be consistent with an overall surface transportation plan**, which specifically acknowledges the importance of private rubber tire passenger and freight vehicle use as the primary means of personal movement and major means of movement of goods, both now and in the future. There is an important place for transit in the overall transit plan, as there is for pedestrian travel and cycling, but, as important as these may be for certain members of the community, the primacy of the Wake County road network, and private vehicle use, must be acknowledged as the

foundation of the local transportation system. Transit planning should attempt, where possible, to integrate with road improvements for the greatest good for the greatest number of residents and visitors.

- The revised Plan must, at the least, **be cleaned of errors** of computation and errors of omission.

- The revised Plan should **target the primary major transit markets** in Wake County – those in need of transitional mobility.

- The revised Plan should ***realistically* consider the likelihood of both State and federal support,** both presently and in the future.

- The revised Plan should **clearly show ridership forecasts, farebox contributions, and farebox percentages.**

- The revised Plan should **specifically consider the roles of the private sector** through appropriate recommendations for privatization of some services and the lowering of costs through the use of competitive bidding, use of smaller vehicles and off-peak labor costs.

- The revised Plan should **specifically consider the coordination or integration of the four Wake County service operators,** and also consider possible integration with the services of neighboring jurisdictions, and provide at least some preliminary idea of how this would be accomplished, coupled with agreement to the principles by the local agency decision makers.

- The revised Plan should specifically **consider how school-bus operations**, serving 3 times the entire public transit ridership with over 900 vehicles[78], can be integrated with the public transportation system, for the mutual cost-effectiveness of both systems.

- Several **promising new technologies** – telecommuting, work-at-home, and 'car sharing and routing' services (people sharing cars, joint rentals, etc, using GPS mobile-phones, social networks, etc) – should specifically be evaluated. Telecommuting in the region is already 5-7 times larger than present transit commuting. These are rapidly growing services that are likely to have significant impacts on Raleigh-area travel in future years.

Public approval for investments of this magnitude demands that the best and most objective information regarding the cost of the investments and their impacts be fully understood. If this review has contributed to that understanding in Wake County, then the authors will have achieved their goal.

[78] In 2009-10 the Wake County Public School System served about 146,138 school-bus student trips daily using 905 vehicles operating 17.8 M vehicle-miles. Average driver per-hour cost for 929 positions 2011-12 is $11.75/hour. Source: Wake County Public School System, Superintendent's Proposed Budget, 2011-12. At www.wcpss.net/budget/2011-12-2pb/

Appendix

About the Authors

David T. Hartgen, Ph.D., P.E. is Emeritus Professor of Transportation Studies at UNC Charlotte and President of The Hartgen Group. Prof. Hartgen is widely known in transportation circles. He is the author of about 358 publications on a wide variety of topics in transportation policy and planning, is US Co-Editor of the international academic journal *Transportation*, and is active in professional organizations. Before coming to Charlotte he directed the statistics and analysis functions of the New York State Department of Transportation and served as a Policy Analyst at the Federal Highway Administration. He holds engineering degrees from Duke University and Northwestern University. His studies of road conditions and his recent national study of congestion reduction also attracted wide national attention. His prior studies of North Carolina transportation issues include numerous assessments of regional issues, state highway funding, congestion, transit performance, sprawl, air quality and economic impacts.

In this review Prof. Hartgen and his staff at The Hartgen Group **M. Gregory Fields** and **Elizabeth San Jose** conducted the assessment of regional economic and demographic trends and participated with Mr. Rubin in the assessment of the Plan's transit operating proposals.

Thomas A. Rubin, CPA, CMA, CMC, CIA, CGFM, CFM is a consultant based in Oakland California who specializes in public sector accounting in transit, highway, school and other public sector initiatives, serving well over 100 transit operator, metropolitan planning, Federal and state DOT, industry supplier, and labor union clients. He has over 35 years of experience in assessing and directing the capital and operating budgets of numerous transportation agencies. He has served as the CFO of the Southern California Rapid Transit District (now Los Angeles County Metropolitan Transportation Authority) and the Alameda-Contra Costa Transit District in Oakland. He holds a MBA with a concentration in finance from Indiana University-Oakland and a BSBA with majors in accounting and finance from the University of Nebraska-Lincoln and has professional licensing accreditation in management accounting, management consulting, internal auditing, and government finance. He is widely regarded in the transit industry as a careful, objective and thorough analyst of both operating and capital plans. In this review, Mr. Rubin conducted the financial assessment of the Plan and contributed with Prof. Hartgen in the assessment of operating and other statistics.

Acknowledgements

This review was conducted with input from several governments, particularly the Capital Area Metropolitan Planning Organization. Numerous other government sources were also consulted through their websites. These include the region's four transit operators, NCDOT, US Census Bureau, numerous regional planning agencies and several media outlets. The John Locke Foundation, a Raleigh-based independent nonpolitical think tank, provided funding.

As independent consultants Prof. Hartgen and Mr. Rubin are expected to be objective, professional and use state-of-practice methods in conducting their assessments. They do not do 'advocate' studies for which specific answers are expected. Prof. Hartgen and Mr. Rubin are not residents of Wake County, have no contractual relationships with any Wake County businesses or governments (excepting the current contract with the John Locke Foundation), and do not own property in Wake County. To ensure independence Prof. Hartgen and Mr. Rubin have retained control over all study products and wording. This report summarizes their views only, and does not necessarily reflect the views of the John Locke Foundation or any organization in Wake County or North Carolina.

Details and Additional Comments

- **Modal shares will not change materially in the future.**

The region's long-range transportation plans indicate that, in spite of major investments, modal shares will not change materially. Table A1 summarizes the forecasts. With the exception of downtown Raleigh (predicated on high estimates of employment, however), regional transit shares are essentially flat.

Table A1: Forecasts of Daily Regional Travel[79]

Region	Mode of Travel	Daily Person-Trips 2005	%	2035 Trips, with Existing and Committed Improve-ments	%	2035 Trips, with Long Range Plan	%	2035 as Percent of 2005
Entire Region	Drive Alone	2,973,000	54.0	6,048,183	54.6	6,002,747	54.0	102
(Wake, Durham areas, plus external travel)	Carpool	2,055,395	37.4	4,065,176	36.7	4,133,075	37.0	101
	Transit	66,777	1.2	103,988	0.9	134,225	1.2	101
	Bike/Walk	406,933	7.4	852,248	7.7	866,107	7.8	113
	Total	**5,502,105**	**100.0**	**11,069,595**	**100.0**	**11,136,154**	**100.0**	102
Downtown Raleigh (1/2 of In and Out)	Drive Alone	105,422	56.7	167,796	56.0	203,485	54.1	93
one way only	Carpool	72,354	38.9	116,360	38.8	148,363	39.5	105
	Transit	2,652	1.4	4,216	1.4	6,662	1.8	151
	Bike/Walk	5,573	3.0	11,183	3.7	17,494	4.7	214
	Total	**186,000**	100.0	**299,554**	100.0	**376,004**	100.0	102

- **The Raleigh area has very low overall density for fixed-route transit service.**

There are 34 UZAs in the US that now have fixed route commuter rail, light rail, and/or streetcar transit service. Adding the Raleigh and Durham UZAs to these, Raleigh would be 5th lowest in overall population density, as indicated Table A2, and Durham, which is proposed to share commuter rail with Raleigh, would be fourth lowest. Of the three ranked below Raleigh and Durham, third lowest Pittsburgh has operated light rail for over a century and has been losing population for many decades, second lowest Nashville operates a commuter rail system with average ridership of 1,628 (one-way) riders each day, and Little Rock has a 3.4-mile streetcar system that carries under 300 (one-way) passengers/day.

[79] Source: CAMPO and Durham LRTPs, op. cit., and private correspondence from E. Johnson, January 10, 2012.

Table A2: U.S. Urbanized Areas with Commuter Rail, Light Rail, and/or Streetcar Transit Service, 2009

Urbanized Area	Population ('000)	Area (Square Miles)	Persons/ Square Mile	Service Operated/Proposed		
				Commuter Rail	Light Rail	Streetcar
Los Angeles--LB-SAna CA	12,163,844	1,668	**7,292**	X	X	
San Francisco--Oakland, CA	3,323,818	527	**6,307**	X	X	
San Jose, CA	1,618,438	260	**6,225**	X	X	
New York--Newark, NY--NJ--CT	18,446,906	3,353	**5,502**	X		
Miami, FL	5,359,016	1,116	**4,802**	X		
Stockton, CA	348,939	74	**4,715**	X		
New Orleans, LA	852,591	198	**4,306**		X	
Denver--Aurora, CO	2,138,243	499	**4,285**		X	
Salt Lake City, UT	968,382	231	**4,192**	X	X	
Phoenix--Mesa, AZ	3,308,396	799	**4,141**		X	
Sacramento, CA	1,477,554	369	**4,004**		X	
Chicago, IL--IN	8,472,015	2,123	**3,991**	X		
Portland, OR--WA	1,839,506	474	**3,881**	X	X	X
Washington, DC--VA--MD	4,301,547	1,157	**3,718**	X		
San Diego, CA	2,788,484	782	**3,566**	X	X	
Houston, TX	4,447,559	1,295	**3,434**		X	
Austin, TX	1,078,716	318	**3,392**	X		
Dallas--Fort Worth--Arlington,	4,714,503	1,407	**3,351**	X	X	
Baltimore, MD	2,151,539	683	**3,150**	X	X	
Seattle, WA	2,987,292	954	**3,131**	X	X	X
Albuquerque, NM	686,790	224	**3,066**	X		
Philadelphia, PA--NJ-DE-MD	5,295,537	1,800	**2,942**	X	X	
Kenosha, WI	118,233	42	**2,815**			X
Minneapolis--St. Paul, MN	2,468,367	894	**2,761**	X	X	
Tampa--St. Petersburg, FL	2,191,045	802	**2,732**			X
Cleveland, OH	1,682,301	647	**2,600**		X	
St. Louis, MO--IL	2,113,914	829	**2,550**		X	
Buffalo, NY	929,378	367	**2,532**		X	
Memphis, TN--MS--AR	986,257	400	**2,466**			X
Boston, MA--NH--RI	4,186,946	1,736	**2,412**	X	X	
Charlotte, NC--SC	946,237	435	**2,175**		X	
Raleigh, NC	**688,448**	**320**	**2,151**	**P**	**P**	
Durham, NC	**320,283**	**157**	**2,040**	**P**		
Pittsburgh, PA	1,684,337	852	**1,977**		X	
Nashville-Davidson, TN	825,172	431	**1,915**	X		
Little Rock, AR	362,908	206	**1,762**			X

X: Service Operated in 2009.
P: Service proposed in *Wake County Transit Plan.*

- **Ridership and fare revenue projections are non-traditional**

As has been discussed above, the general approach to transit planning begins with demand for services and then attempts to match up supply to that demand, with variation of

factors such as the amount, types, physical location, frequency, times of day/days of week, fares, transfers, subsidy funding available and possible, etc. to fine tune the service to be operated within available and potential funding levels to produce the greatest good for the greatest number, referring to transit service clients, other surface transportation users, and the taxpayers.

There is no 'demand' component in the *Wake County Transit Plan*. Not only is it not possible to determine how well the match between demand for transit services, transit service operated, and fiscal reality was made, it is not even possible to determine, from the Plan, what the expected transit utilization, expressed in terms of transit trips and/or transit passenger-miles, is expected to be. This is somewhat analogous to seeing a proposal to build a new highway without any data on the expected vehicle-miles traveled, or to construct a new long-distance high-voltage electrical intertie component without a projection of expected electrical demand, or a high-capacity sanitary sewer pipe without any idea about what the demand for that infrastructure component is expected to be. It is difficult to determine how well a proposed solution is addressing the problem when the size and scope of the problem is not presented. Fortunately, there are certain elements in the Spreadsheet, although not in the Plan, that do shed some light on this and we have used them, and other transit industry data and experience, to develop our own transit utilization projections, based on the Plan and Spreadsheet.

However, before we examine what is anticipated for the future, let us begin with some common transit industry metrics and a baseline of performance for the existing Wake County transit operators. Consumption of transit is typically measured in terms of passenger trips, which can be subdivided into linked and unlinked, and passenger-miles. A *linked transit trip* will take a single traveler from origin to destination, regardless of the number of transit vehicles utilized, while an *unlinked transit trip* occurs whenever one rider boards one transit vehicle. So, if a rider takes a bus from near home to a light rail station, then takes the train to the station nearest the place of employment, and then takes another bus for the last mile to the job site, that is one *linked* transit trip, but three *unlinked* trips. For transportation planning purposes, linked trips are far more important, but they are very difficult for transit operators to keep track of on a continuing basis – and so the industry generally settles for reporting what is relatively easy to measure consistently, unlinked trips. A *passenger-mile* is one person riding on a transit vehicle for one mile.

Unfortunately, we do not have direct data on trips, linked or unlinked, in the Spreadsheet or the Plan, but we do have some passenger-mile data, which we can make use of.

Transit ridership varies with many factors, but one well-known variable is fare level – low fares will attract more riders than high fares. The current level of fares and ridership can be utilized as a baseline demonstrating how transit fares and transit use has equalized in Wake County in recent years, which is a useful mark to comparison to the results reported in the Spreadsheet. Two very commonly utilized transit utilization and productivity metrics are *boardings per vehicle revenue service hour* – the average number of riders who board a transit vehicle in an hour of service to the public – and *average passenger load*, which is passenger-miles divided by vehicle revenue miles, or the average annual number of riders on board a transit vehicle. We will use these metrics on an annual basis by fiscal year.

For FY10, the three fare-charging motor bus operators in Wake County (leaving out NCSU), collectively, reported average boarding per vehicle hour of 21.6 and an average passenger load of 6.5[80] – on buses that average approximately 40 seats, exclusive of standing

[80] Federal Transit Administration, National Transit Database, authors' calculations from the "profiles" for the four operators for 2010: http://www.ntdprogram.gov/ntdprogram/data.htm

room for approximately 20 additional passengers at peak load points. The national averages for all motor bus operators for 2010 were 33.5 for boardings/hour – approximately 55% higher than the Wake County operators – and 10.7 for average passenger load – approximately 65% higher[81].

Looking now at the Spreadsheet, there are factors presented for annual vehicle revenue miles per bus (40,327[82]) and passenger-miles per bus (184,626[83]) – which produce an average passenger load of 4.6 for the bus service proposed to be added in the Plan. This is approximately 71% of the value for the existing Wake County bus service and approximately 43% of the national average for all bus transit operators.

In reviewing the level of performance of the current Wake County bus service, it could be argued that the level of performance on these two indicators means that there is no great demand for bus transit services in Wake County, and/or that the current service does not well serve the potential riders; However, it should be noted that transit utilization in smaller communities, such as those in Wake County, is almost always significantly less than in larger communities such as greater New York City or the San Francisco Bay Area. However, the assumed level of performance of the service proposed to be added in Wake County, which is far lower than that of the existing Wake County service, speaks for itself.

Let us now bring in fare revenue. We will do this calculation only for three of the Wake County transit operators. (Riders do not pay per boarding when using North Carolina State University buses. Instead, each student is assessed a mandatory fee of $71.50 for "Transit Operations" each semester for an undergraduate who is carrying twelve or more credit hours in the current term[84]). So, to avoid inconsistencies in what fares should or should not be for off-campus transit travel, we will only consider fares paid for Capital Area Transit, CTRAN, and Triangle Transit. The combined average fare per boarding for these three operators for the 2010 reporting year was $0.605; the combined average fare per passenger-mile was $0.115. We will use the data for FY25 for the following analysis because that is the first year when the full 170 new peak period buses will be in service, providing the entire proposed program of expanded bus services[85].

The Spreadsheet assumes that all costs will rise with inflation each year, and the same inflation factor is used for all costs and revenues. The Spreadsheet shows total bus operating costs of $51.975 million[86] in FY25, and assumes that farebox revenues will cover 15% of that[87], or $7.796 million[88], and there will be 31,386,347 passenger-miles of bus transit service consumed[89]. If we divide the annual farebox revenues by the annual passenger-miles, we get an average fare per passenger-mile of $0.2484 – in FY25 dollars. Using the inflation assumptions

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[81] FTA, NTD 2010, authors' calculations from data in "Service" table:
http://www.ntdprogram.gov/ntdprogram/data.htm

[82] Spreadsheet, "FTA 5307 Grant Revenues" tab, row 27.

[83] *Ibid.*, row 31.

[84] NC State University, Cashier's Office and Student Accounts, "Itemization of Required Undergraduate Fees – 2011 Fall Semester – Spring 2012 Semester:
http://www.fis.ncsu.edu/cashier/tuition/11-12UndergradFees.pdf

[85] Spreadsheet, "FTA 5307 Grant Revenues" tab, cell X20.

[86] *Ibid.*, "Combined Transit Summary" tab, cell Y183.

[87] *Ibid.*, "Bus Srvcs – System Unallocated" tab, cell Y29. For the 2010 NTD reporting year, the national average farebox recovery ratio for motor bus services was 26.6% (author's calculation from NTD, "Fare Revenue Earned by Mode" and "Operating Expense" tables).

[88] *Ibid.*, "Combined Transit Summary" tab, cell Y22.

[89] *Ibid.*, "FTA 5307 Grant Revenues" tab, cell X32.

to work backwards to FY10 dollars produces total inflation, FY10-FY25, of 46.2%[90], *so the FY10 dollar average fare per passenger-mile is $0.1715, or 54% higher than the FY10 actual fare per passenger-mile, $0.1115.*

There are several ways to look at this:

1. The average fare for the new bus service will increase 54% more than inflation. However, this should not be thought of as something that is spread out over the 15-year period between 2010 and 2025. All of the assumptions for the bus service, including the 15% farebox recovery ratio, the constant dollar cost per hour of operations, the passenger-miles per bus, etc., are the same for every year of the bus service in constant dollars. That means that the fares per passenger-mile will go up 54% in the first year of the added bus service, FY13.
2. Consistent with 1. above, it is the increase in fare per passenger-mile that causes the decline in transit utilization. This would mean that a 54% increase in fare level causes a 29% decline in transit utilization, which is a fare elasticity of -.534 – which is not inconsistent with the national experience in for fare increases and changes in ridership levels[91], particularly considering that much of the service to be added will be in areas where lower levels of transit utilization could be reasonably expected.
3. The 15% farebox recovery ratio will not be met.
4. The 15% farebox recovery ratio is really nothing more than an assumption, not a product of analysis – without any justification based on actual analysis of projected transit usage, fare levels, and fare revenues.

As the added bus service will be intricately intermixed with existing bus and other transit service (indeed, much of the proposed added service is adding more buses and hours of service on existing bus lines and extending existing bus lines into previously un-served areas), it appears that, to increase the fares collected for the added services, the fares for both must be identical, which would require that the fares for existing transit services also increase by 70% and this increase would go into effect when the first added services would go into operation – which is April 1, 2013, according to the Spreadsheet[92].

While the above is the only course of events that would allow all the assumptions in the Spreadsheet to occur, it should be pointed out that, as we explain below, baring some events that are not discussed in the Plan, the first added service will not be seen for approximately two years after that date. It is also fair to observe that it is very doubtful if the authors of Plan had thought this through and realized the implications of their assumptions; in other words, it is far more likely that the Plan and Spreadsheet assumptions will be changed than this level of fare increase would be implemented less than five months after an election when the voters are asked to pass new taxes for transit improvements.

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[90] *Ibid.*, "Assumption Summary" tab, row 127. There is not a specific set of inflation assumptions for fares; however, there is a specific set of inflation assumptions for bus operating costs, an assumption that fares will cover 15% of operating costs in each year, and that passenger-miles will remain constant over the period. Therefore, the operating cost inflation assumption, mathematically, *is* the inflation assumption for fare per passenger-mile.

[91] American Public Transportation (*nee* Transit) Association, *Fare Elasticity and Its Application to Forecasting Transit Demand*, 1991: http://apta.com/resources/reportsandpublications/Documents/Pham_Linsalata_Fare_Elasticity_1991.pdf

[92] Spreadsheet, "FTA 5307 Grant Revenues" tab, cell L14.

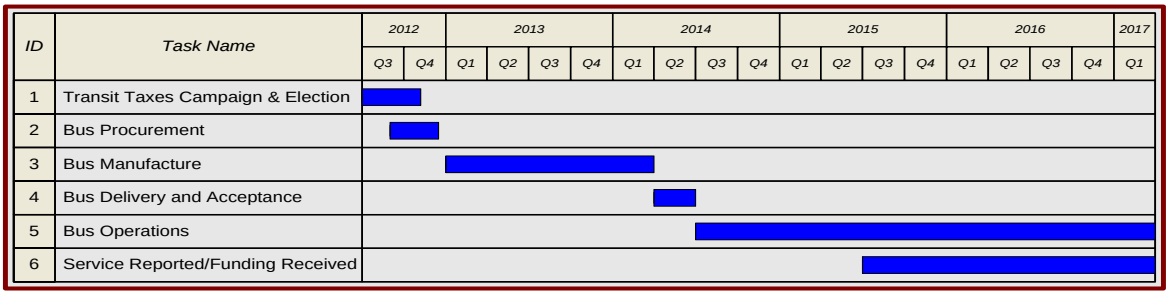
- **Timing of start-up and receipt of federal funds is unrealistic.**

The Plan, taken together with the Spreadsheet, explicitly or implicitly includes a schedule of events leading to the introduction of new bus service and the generation of additional Federal funding that does not appear to be remotely possible.

1. Voter passage of the transit taxes (November 6, 2012)[93]
2. Procurement of buses for new bus service[94]
3. Progress payments for these buses
4. Delivery and acceptance of these buses
5. Buses placed into revenue service April 1, 2013[95], which generate Federal Transit Administration (FTA) 49 USC 5307 "Formula" funds[96]. (This is, by far, the largest FTA grant program. The funds each urbanized area (UZA), such as the Raleigh-Cary UZA, receives each year are calculated based on, among other things, the amount of transit service that each transit operator provides; operating more vehicle revenue miles of transit service, such as is proposed in the Plan, would generate more Formula funds.)
6. Formula grant funds received in FY13[97]

Below, we provide a more realistic progression of events from the passage of the new transit taxes to the actual receipt of the Federal Formula grant funds. As we detail below, there can be substantial variation in how long individual tasks will take; we show the normal range and pick a value we believe reasonable, given what is now known and can be reasonable anticipated. (Note that the years shown in the timeline are *calendar* years, *not* fiscal years.)

Figure A1: A Realistic Timeline for the Wake County Transit Project



The rationales behind the above are:

[93] *Ibid*., "NOTES – Core Financial Plan," line 13; see also Plan, "Model Notes," labeled "page 10 of 10;" page 146 of 172 overall.
[94] Spreadsheet, "Section 3 – Bus Service" tab, cell L15; see also Plan, "Transit Summary," labeled "page 1 of 9;" page 128 of 172 overall.
[95] *Ibid*., "FTA 5307 Grant Revenues" tab, cell L14. Obviously, for the buses to be placed into service, the progress payments, delivery, and acceptance of these buses must have been completed. While it is not unknown for buses to be placed into revenue service while there are still unresolved – and unpaid – items impacting full and final acceptance, these are generally minor in comparison to the full price of the vehicles and full acceptance and payment is generally completed within a few months of the buses being placed in service.
[96] *Ibid*., "Combined Transit Summary" tab, cell M47; see also Plan, "Transit Summary," labeled "page 1 of 9;" page 128 of 172 overall.
[97] *Ibid.*

1. Transit Taxes Campaign & Election: This is the least variable, assuming that the election is held as assumed in the Spreadsheet, November 6, 2012.
2. Bus Procurement: We assumed that the actual procurement documents would be released to potential suppliers on September 1, before the election, and the actual contract execution would be in mid-December, immediately after the Wake County Board of Commissioners make their decision to impose the taxes[98]. Note that the creation of a bus procurement document is a complicated process. While there are no shortage of such documents in existence to borrow from, one critical matter for Wake County is that multiple bus operators will be making a commitment to a specific type, or types, of buses over what is shown as the procurement of 130 buses over a five year period and five buses a year for the next eight years[99]. Getting agreement on bus specifications within a bus operator is not a simple, or quick, task, and getting three or four different operators to agree is much more complex; this could complicate the procurement process and extend the schedule.
3. Bus Manufacture: For a bus order of this size (25 buses), it generally takes approximately twelve to eighteen months from the execution of a bus purchase contract until the delivery of the last bus in the order, depending more on the state of the bus manufacturers' order books than anything else. We assumed fifteen months. The common method of contracting for bus purchases includes progress payments, which are generally negotiated specifically for each individual procurement[100].
4. Bus Delivery and Acceptance: Once the buses have arrived on property, transit agencies generally take a few months to get them ready, train the operators and mechanics in their use, and assure that all contract requirements have been satisfied and the buses are safe and fit to operate in passenger service. We have allowed three months for this. Since these buses are being acquired for expanded service, this includes the time for the initial training for new employees in the agency and the transit industry.
5. Bus Operations: We show the buses going into revenue service on July 1, 2014 (the first day of FY15). Because an order of 25 buses (the first year order) is generally received over a period of several months, and generally are assigned to begin the new routes when enough buses have been received to operate the full service on each line, one line at a time, the July 1st start date should be considered the mid-point of getting all 25 new buses into service.
6. Service Reporting/Funding Received: Assuming buses are placed in service on July 1, 2014 (approximately 20 months after the election that approved the proposed new transit taxes), the service that is operated with them is reported for the fiscal year ending June 30, 2015. The annual data reported by the Wake County transit operators is combined with the data for all other transit operators that report service for year ends through December 31, 2015. When all the data is collected and validated, it is

[98] *Ibid*., "NOTES – Core Financial Plan" tab, line 15; see also Plan, "Model Notes," labeled "page 10 of 10;" page 146 of 172 overall.
[99] *Ibid*., "Bus Srvcs – System Unallocated" tab, line 15.
[100] See, for example, American Public Transportation Association, *Standard Bus Procurement Guidelines RFP*, Section SP 5.1, "Payment Terms," pp. 51-2:
http://apta.com/resources/reportsandpublications/Pages/BusParatransit.aspx

entered into the formula, and then, when Congress appropriates the total 49 USC 5407 funding "pot" for the Federal fiscal year beginning October 1, 2016, the amounts for each urbanized area are the outputs. Unfortunately, it has been rare for a Federal budget to actually be approved for this program prior to the beginning of the year, which causes significant delays in the actual distribution of the funding – and there have been several years when the funds were not available until well over half of the fiscal year was completed. We have assumed that funds would be received half-way through Federal FY17, on March 31, 2017 – or approximately *four-and-one-half years following the voter approval* of the proposed new transit taxes, rather than the no-later-than-eight months projected in the Plan and Spreadsheet.

Interestingly, it appears that those who constructed the Spreadsheet were aware of at least some of the above, including the most important, the last. There is an actual row in the Spreadsheet, "No. of Years for Funding Lag," with "2" (for two years) in every appropriate cell of the specific years[101] – but, despite this, the Formula funds are shown as being received in the year that the transit service that generated this specific funding is operated.

There is no explanation of how expanded bus service can begin April 1, 2013, when there is clearly not sufficient time to procure, have manufactured, receive, and make ready for service the buses to operate it. It may be that the authors of the Plan are anticipating leasing buses, or making other arranges to acquire buses to operate the new service, but there is no mention of this in the Plan, nor provision for these expenses in the Spreadsheet. It may also be possible that the Plan authors are anticipating that the new service will be started with the buses already on hand (possibly present 'spares'), but this would appear to be, at a minimum, extremely difficult, and more likely impossible, at least for the full number of required buses (in fact, as discussed below, it appears that it will not be possible to operate the level of new service specified in the Plan and Spreadsheet with the projected level of buses to be acquired) – and, again, there is no mention of this in the Plan.

It may also be argued that those who prepared the Plan were aware of these delays and compensated for them by providing for more cash shown coming in than going out; for example, at the end of FY19, there is a cash on hand balance shown of $22.0 million, which is more than twice the $10.1 million in delayed receipt of funds that we calculate from the four-year delay explained above[102]. Perhaps, but this would be a strange – and unexplained – method of preparing a complex financial plan that, at a minimum, reduces the cash safety factor significantly after planned expenditures of $229.5 million[103].

- **The analysis over-states Federal bus service support in some regards**

The analysis uses a value of Federal support, per revenue vehicle mile, to estimate Federal reimbursement. This value is calculated beginning with a value of $0.5404 in FY07

[101] "FTA 5307 Grant Revenues," line 19.

[102] Spreadsheet, "Combined Transit Summary" tab, cells M47-S47; six-year total 5307 receipts of $13.076 million per Spreadsheet vs. our recalculation of two years of receipts totaling $2.957 million; see also Plan, "Transit Summary."

[103] *Ibid.* cells M225-S225. (All of these values are carried to eight decimal points in FTA notices and the Spreadsheet; we have limited the presentation to four decimal points, which we believe sufficient for the instant purpose.)

(source not specified, the actual value was $0.5107[104]), then multiplying it by inflation factors for each year to FY13, the first year where the new transit operations are shown as producing Formula funding, to produce a value of $0.5819 in FY11 and $0.6114 in FY13[105]. However, the *actual* value for FY11 was $0.5363, which was and is readily available on the FTA web site[106]. This means the values in the Spreadsheet are an over-statement by approximately 8.5% in every year.

The methodology in the Spreadsheet is also incorrect in factoring the added service in the wrong year, the year it is operated rather than two years later, with a higher value per vehicle revenue mile of service.

- **Errors in bus service reimbursement under-state total Federal support.**

Once the basics are properly in place (bus service begun only when buses are available, two-year time lag between service operated and funding received, starting with the correct base year value per VRMi, multiplying the VRMi by the factor for the proper year), the actual computation is relatively simple – multiply the VRMi operated in year X by the proper value for year X+2 to produce the grant amount generated for year X+2. The spreadsheet appears to be structured to make this computation (although with the various errors listed above). However, rather than using this methodology, an alternative methodology is utilized that basically increases the value for Formula funding for the added bus service by an inflation factor each year. This produces an over-statement of revenues in the early years, but an understatement in the "out" years. After correcting for all the above errors, we believe that the total 49 USC 5307 Formula grant funds generated by the added bus service, shown at $90.711 million through 2040[107], should be $126.101 million, *therefore Federal bus service support is actually understated by an additional $35.4 million through 2040.*

- **Federal funds for Commuter Rail formula funding are significantly under-stated.**

For reasons we do not know, the Spreadsheet has no calculation of the 49 USC 5307 Formula grant funds that would be generated by the operation of Commuter Rail and Light Rail service.

Due to the lack of data in the Plan and Spreadsheet on commuter rail operations, we were forced to use alternative means to calculate the potential Formula funding that this service could operate. From the U.S. national commuter rail totals for 2009, we calculated the average cost of a commuter rail vehicle revenue hour (each passenger car in a trainset is counted as a separate vehicle) as $453.50[108]. As the vast majority of current commuter rail service is operated in high-cost large urban areas such as New York City, Chicago, Philadelphia, Boston, and Washington, DC, perhaps the operating costs may be lower in Wake County – or, perhaps, diseconomies of

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[104] "Federal Transit Administration – Table 5 – Fiscal Year 2007 Formula Programs Apportionment Unit Values," "Urbanized Areas Under 1,000,000 – Bus Revenue Vehicle Mile."
http://www.fta.dot.gov/12853_6546.html

[105] *Ibid.* "FTA 5307 Grant Revenues" Tab, cells F29, J29, and L29.

[106] "Federal Transit Administration – Table 5 – Fiscal Year 2011 Formula Programs Apportionment Unit Values," "Urbanized Areas Under 1,000,000 – Bus Revenue Vehicle Mile."
http://www.fta.dot.gov/grants/12308_13308.html

[107] Plan, "Revenue and Expenditure Summary for the Core and Enhanced Transit Plans," page 39.

[108] APTA, *2011 Public Transportation Fact Book*, Table 27, "Rail Modes and Ferry Boat National Totals, Report Year 2009," page 30:
http://www.apta.com/resources/statistics/Pages/transitstats.aspx

scale may push costs up. Without a provable rationale to move this figure up or down, we used it unchanged, escalated it to the beginning of commuter rail operations in 2020 and thereafter, and utilized the distance and time data from the Plan – 37 miles between West Durham to Garner in 52 minutes[109] – to calculate a 42.6 mph average speed of travel[110]. Operating cost divided by cost/hour ➔ revenue hours of service x average speed ➔ vehicle revenue miles x value per revenue mile ➔ annual Formula funding generated.

There are two more elements of Formula grant funding that are important in this context, known as the commuter rail "floors." Under the provisions of 49 USC 5336(b)(2), any urbanized area with a population of 750,000 or more[111] that operates commuter rail transit service must receive a specified minimum percentage of the total 5307 Formula funds allocated to rail transit operations; for 2011, these amounts are $8,866,009 for fixed guideway route miles and $407,089 for the incentive tier[112]. With commuter rail service projected to start in FY20, we project that commuter rail-generated Formula funding, beginning in FY22 at $12.7 million, will total approximately $323 million through FY40.

- **Potential Federal support from the Fixed Guideway Modernization Program (49 USC 5309) appears to have been overlooked.**

Another FTA grant program that is not in the Spreadsheet is the Fixed Guideway Modernization program (49 USC 5309). These funds are distributed under a complex, multi-tiered program that requires several years of continuous service to reach the top level. Again applying the FY11 FTA values, we calculate that by FY40 the annual Fixed Guideway Modernization funding generated by commuter rail operations will be approximately $5.9 million a year. Over the full period where such funding will be generated, total funding will likely exceed $60 million, mostly in the last decade of the Plan period.

- **Federal formula support for Light Rail appears to have been under-stated.**

As with commuter rail, the Plan and Spreadsheet are silent on the grant funds that would be generated by light rail and, as with commuter rail, the Plan and Spreadsheet are light on detailed operating statistics that can be utilized to approximate what they could produce.

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[109] Plan, "Recommended Commuter Rail Service," page 16.

[110] Which, based on the operating data of existing commuter rail operators, appears high to us; we made no modifications to this speed for purposes of the above calculations.

[111] As of the time of preparation of this paper, the Census Bureau had not released UZA population data. (Telephone conversation, David Schneider, Office of Program Management, FTA, January 3, 2012 and e-mail exchange with Census Bureau, January 3, 2012.) However, the Raleigh-Cary, NC UZA had a population of 541,527 as of the 2000 Census. (FTA, National Transit Database, Capital Area Transit "profile" for 2010: http://www.ntdprogram.gov/ntdprogram/pubs/profiles/2010/agency_profiles/4007.pdf). The Raleigh-Cary, NC Metropolitan Statistical Area (MSA, unlike UZA's, *are* defined by political boundaries) had a growth rate of 41.8% from 2000 to 2010, making it the fourth fasting growing MSA in the nation. (Census Bureau, *Population Distribution and Change: 2000 to 2010*, Table 3, "Population Change for the Ten Most Populous and Ten Fastest-Growing Metropolitan Statistical Areas: 2000 to 2010," page 6: http://www.census.gov/prod/cen2010/briefs/c2010br-01.pdf). If the Raleigh-Cary UZA experienced the same 41.8% growth from 2000 to 2010 as the Raleigh-Cary MSA (and it likely experienced higher growth as the UZA boundaries were expanded to include newly developed residential areas between 2000 and 2010), the 2010 UZA population would be approximately 768,000. This appears to be a sufficient margin of confidence to conclude that the Raleigh-Cary UZA will satisfy the 750,000 population criterion when the 2010 Census data is applied for this purpose, beginning with the 2013 FTA Formula grant distribution year. (Schneider)

[112] FTA "Table 5."

The calculations for light rail are simplified by the commuter rail "floors" discussed above. Since these two floors effectively produce far more grant funding for the Raleigh-Cary UZA than would be produced by multiplying the actual quantities of directional route miles and the incentive tier by the values for the appropriate years for the sum of commuter rail and light rail service, and the plan is for commuter rail to enter service prior to light rail, these items can be disregarded for this purpose.

That leaves us with the Formula funding generated by vehicle revenue miles of service. We utilized the same methodology, and sources, as described for commuter rail above, we calculated that the light rail operations in the Spreadsheet, commencing in FY22, would produce approximately $51 million of 49 USC 5307 Formula grants and over $120 million of 49 USC 5309 Rail Modernization funds over the Plan period through FY40.

A critical part of this methodology involves the operating speed assumption. The Plan states that the initial LRT route alignment will be between downtown Cary and Northeast Raleigh, a distance of 13.9 miles, and that this distance will be traveled in 28 minutes[113], producing an average speed of 29.8 mph. This speed appears very excessive to us, but we did not modify for purposes of the above calculation. In essence, we are assuming the miles of services specified will be operated, even if speeds are lower than assumed and it is necessary to buy and operate additional transit vehicles to operate that level of service.

- **Additional problems with Plan assumptions**

There are several elements of the Plan where the operating assumptions are questionable, or clearly impossible, to produce in actual transit operations.

  - **Bus 'Spare Ratio'**

The first of these is the bus 'spare ratio.' It is impossible to operate a transit service schedule without the existence of a fleet that has an *excess* of vehicles over the maximum peak period usage. Some buses are always out of service due to major maintenance and/or repair work, vehicles must be available to pull out to replace vehicles that break down in service, other buses are required to be available for training of new operators, etc.

FTA has established a guideline of a 20% spare ratio – that is, if 100 vehicles are required to operate service at the peak of the peak period, then a total vehicle fleet of 120 will generally be acceptable to FTA – for grant recipients operating fleets of 50 or more fixed-route buses[114]. The four Wake County bus operators have generally operated with spare ratios higher than 20%. At the end of 2010, they collectively had 215 buses on hand against a 150 peak requirement, a spare ratio of 43%, with an overall average of 37% over the period 1996-2010[115].

However, the bus operations in the Spreadsheet are shown with a *zero* spare ratio. "Revenue Miles for Total Accumulated Bus Fleet," the annual total vehicle revenue miles for all

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[113] Plan, "Enhanced Transit Plan – Light Rail Transit – Cary/Raleigh (Millbrook Road," pp. 26-27.

[114] FTA, Circular C 9300.1B, "Capital Investment Program Guidance and Application Instructions," November 1, 2008, Chapter III."Buses and Bus Facilities," §7.b.(2), "Spare Ratio Policies," page III-7: http://www.fta.dot.gov/documents/Final_C_9300_1_Bpub.pdf. There are often good and acceptable reasons for exceeding this 20% guideline, particularly at specific points in time. For example, it is common for bus operators to keep older buses in the process of being replaced by newer buses on the property for a period during the transition, and some operators have FTA-approved contingency fleets on hand to respond to emergencies, such as high demand for transit during periods of large increases in motor fuel prices.

[115] FTA, National Transit Database, "profiles" for the four operators for the 15 years between 1996 and 2010, inclusive, as appropriate.

buses obtained through each fiscal year, is calculated by multiplying the total number of buses that have been procured ("Expanded Bus Service Project – Acc. Bus Fleet") by a factor of 40,237 "Revenue Miles for Total Accumulated Bus Fleet" for each[116]. The 40,237 is a close approximately of the 40,390 average revenue vehicle hours for each of the 150 peak services buses operated, in total, by the four Wake County bus operators in 2010[117]. Their total bus fleet was 215 in that year, so the actual average vehicle revenue miles per *total* bus fleet bus was 28,072.

To operate the level of service specified, more buses must be purchased. We are going to arbitrarily choose a spare ratio of 25% – higher than the FTA's 20%, but a lot closer to that 20% than the long-term 37%, not to mention the current 43% – so, to operate 170 *peak* buses that the Spreadsheet shows in service by FY25[118], an additional 43 buses must be purchased. At they will be purchased at the same time as the other buses, this will add $63.4 million, in current year dollars, to the purchase price of the fleet expansion buses and their replacements.

As the operating costs were calculated by multiplying vehicle revenue hours times a cost/hour factor, this will likely have little, if any, impact on operating costs. The hours projected will be operated, it appears, and so we will assume – it is just that it will require the Wake County transit operators to buy more buses to be able to operate that number of hours.

- **Commuter Rail operating speed appears to be substantially over-stated.**

As we indicated above, the average operating speed of 42.6 mph appears high to us. Commuter rail is generally the fastest transit mode; the national average for 2009 was 31.2 mph[119].

However, this value is not directly comparable to the 42.6 mph for Wake County because of the way that National Transit Database data is defined. Vehicle revenue hours include layover and recovery time at the ends of runs while the transit vehicle is stopped, awaiting the return trip. Because vehicle revenue hours include time not in motion in revenue service, when NTD vehicle revenue miles are divided by vehicle revenue hours to produce miles per hour, the result is an understatement of actual operating speed. There are many factors that can produce this 'time not in motion' in vehicle revenue hours, so a simple adjustment factor is not possible. The difference is often in the range of 5 to 10% – but the Wake County commuter rail speed being 37% higher than the national average is clearly an outlier.

There are also many things that can impact average operating speed, including the condition of the track, grades and curves, crossings, noise and safety restrictions, schedule conflicts with freight operations, etc. Many of these, we are unable to access and we will not attempt to – but we will observe that the proposed alignment is far from the straightest one for commuter rail we have ever observed.

One factor we *will* consider is the average distance between stations. The more time that trains spend at full operating speed, and the less they spend slowing for and accelerating out of stations, and stopped at them, the faster the operating speed. For the entire U.S. commuter rail mode, there were 7,786.2 directional route miles, or the equivalent of 3,893.1 bi-direction miles, and 1,225 stations[120] which equates to an average of 3.18 miles of bi-directional commuter rail

[116] Spreadsheet, "FTA 5307 Grant Revenues" tab, lines 28, 20, and 27, respectively.
[117] FTA, NTD, "profiles" of the four operators for the 2010 reporting year.
[118] Spreadsheet, "Bus Srvcs – System Unallocated" Tab, cell X17.
[119] APTA, Table 27.
[120] FTA, National Transit Database, 2010 Tables, "Transit Way Mileage" and "Transit Station," respectively.

track for each commuter rail station. For a multitude of reasons, this value is not and will not be represented as average distance between stations, but is a reasonable approximation. For Wake County commuter rail, 37 miles of bi-directional alignment and twelve stations (between West Durham and East Garner) produces 3.08 miles of bi-directional track for each station, slightly lower than the national average. We will not attempt to overemphasize the importance of these relative standings, but it is fair to stay that Wake County commuter rail does not appear to have any substantial advantage leading to greater average speed of travel from this metric.

If the operating speed is over-stated, then there would be several impacts on commuter rail service and costs:

1. The faster the operating speed, the more attractive the service, all else equal. If the speed is less than now projected, commuter rail service will be less attractive to potential riders – and ridership will be lower.
2. If the speed is significantly slower than what is now projected, it will become impossible to meet the operating schedule without adding a trainset (or perhaps trainsets), which will cause the following increase in costs:

    a. The capital cost of the additional trainset(s)
    b. The cost of operating the additional transit(s)

3. Conversely, if the slower speed causes the loss of sufficient anticipated riders, service may be reduced. This will mean less total spending, but the costs and subsidies per passenger will be higher, and the anticipated benefits of commuter rail ridership will be reduced.

- **Light Rail operating speed also appears to be over-estimated.**

While there are strong reasons to believe that the 42.6 mph commuter rail average operating speed is over-stated, *there is absolutely no doubt that the 29.8 mph light rail operating speed is significantly over-stated*.

The national average light rail operating speed is 15.1 mph[121]. This is subject to the same issue involving the NTD definition of vehicle revenue hours as explained for commuter rail, and, in addition, NTD "light rail" statistics include a relatively small quantity of streetcar operations, which are traditionally far slower than "true" light rail – but the Wake County light rail is shown as operating 97% faster than the reported national average.

Considering actual operating speed for existing systems, there is only *one* light rail line in the U.S. that has an operating speed faster than what is projected for the Wake County line: the Los Angeles Green Line, which covers the 20 miles[122] between Norwalk and Redondo Beach in 34 minutes[123] – 35.3 mph. However, the Green Line, while meeting all the technical criteria to be classified as a light rail line, is a light rail line like no other – it operates on a 100% exclusive right-of-way with not a single at-grade crossing, does not serve a downtown area, has the longest

[121] APTA, Table 27.
[122] Los Angeles County Metropolitan Transportation Authority (Metro), "Line Notches 33,000 Average Weekday Boardings In October, November 29, 2001, http://www.metro.net/news/simple_pr/line-notches-33000-average-weekday-boardings-octob/
[123] Los Angeles County Metropolitan Transportation Authority, Metro Green Line Schedule: http://www.metro.net/riding_metro/bus_overview/images/803.pdf

average distance between stations of any light rail line (over 1.5 miles), and operates at a top speed of 65 mph – vs. the 55 mph that even other light rail lines with exclusive rights-of-way top out at. There are several other U.S. light rail lines that approach 25 mph, including the Long Beach to Los Angeles Blue Line, the Pasadena Gold Line, and the original Saint Louis Metrolink line from the airport to downtown and East Saint Louis. All of these lines have extensive exclusive guideway sections where they operate at 55 mph and a minimum of slower speed sections.

Doing the same guideway to station comparison that we presented for commuter rail, the national totals for light rail for the 2010 NTD reporting year were 1,664.3 directional route miles ➔ 832.2 bi-directional miles, compared to 848 stations, or 0.98 miles of track per station. The proposed Cary to Millbrook alignment has sixteen stations[124] in its 13.9 miles, a ratio of 0.87 miles of track per station – which is a significant difference in this context that will have a *negative* impact on speed.

Even these basic comparisons are sufficient to establish that the 28-minute end-to-end travel time is significant under-stated. The longer travel times will require additional trainsets to be procured and operated to maintain the stated headways, which will increase operating costs significantly – and the longer travel times will have a negative impact on ridership. Alternatively, this added service will not be required because the ridership anticipated at the higher speeds never appears.

- **Route details raise questions.**

The Plan's route details[125] leave many questions. This appears to be a preliminary quantification of the hours, number of buses, and costs to operate each, and there are a number of obvious errors. The totals for hours, bus requirements, and cost do not match the spreadsheet, all three are significantly higher. This may be due to a lot of the routes in this list being expansions of existing routes, so perhaps all three totals include the service that is now being operated, although this would appear to be a different way of presentation than everything else in the report. Of course, this does make the line-by-line descriptions a lot easier to understand, but normal practice would have an explanatory note of what they were showing, how the calculations were done, and what was and was not included. Another concern is that the bus requirements are, ignoring the errors, the number of buses required to operate the peak service; there is no provision for spares, which, at least, is consistent with the main report. A third problem is that there appear to be inconsistencies in the details of route location, end points, and scheduling. There are a number of obvious errors, such as having more annual service hours per bus than there are hours in a year, a schedule that cannot be operated with the number of buses specified, etc., and two routes that are both included twice, on separate pages. All of these, taken in combination, do not provide a high degree of confidence in the overall accuracy of these elements of the Plan and the planning process.

- **Will "Timed Transfer" Service Work?**

It is difficult to provide good transit service to the type of low-density areas that are such a large portion of the urban and suburban segments of Wake County, because low levels of ridership lead to long intervals between buses and inconvenient transfers, which can also require long waits.

[124] Plan, Appendix F, "Proposed Light Rail Transit Station Locations," page 116.
[125] Plan, p. 47-112.

A well-known methodology for service to these types of areas is what is called "timed transfer," aka "surge" or "pulse" service. For each area to be served, a central point is established where, at the designated times, such as every 30 or 60 minutes, all the buses converge and wait while their riders transfer between buses without long delays or risk of missing their connections. Although there is no specific mention of "timed transfer" or similar terms in the Plan, the various actors – the low density of the area, the long, but consistent headways of the routes (mostly 30 minutes, with some 15 minutes and a small number of 60 minutes), the large number of transit centers – leads us to believe that this is, in fact, the intention. If so, we agree with this general approach (although we reserve judgment on the specific elements), in fact, it is difficult to come up with another fixed route service approach that would be any near as appropriate.

While timed transit is a very valid approach to providing transit service to this type of area, there are issues that arise with it, including:

1. Because all buses serving the same transit center must be there at the same time, and because the route lengths and speeds of travel never match precisely, timed transfer systems tend to have long layover/recovery times when the bus is not in motion – but the operator is being paid and other expenses continue.
2. Mid-route stops at transit centers, which can often involve routing that varies from the most direct travel between the two terminuses of the route, generally mean that the actual speed of travel for this type of service is somewhat slower than for conventional design transit route systems. In addition, mid-route stops seem particularly long, and speed of travel low, for those who must stay on a bus that is not moving, stationary at a transit center for some minutes.
3. Several of the bus transit centers are also located at what are planned to be rail stations – which, again, is a very common design element for timed transfer service. However, this generally means that each bus must arrive at the center before the train, including the time required for a transportation-disadvantaged passenger to exit the bus and access the rail platform to be ready when the train arrives, and the bus must remain in place for enough time for a transportation-disadvantaged passenger to exit the train and reach the bus. This can slow speed of travel even further, particularly if the train is running late and policy is to wait until it arrives unless specifically authorized to leave by dispatch or road supervisors.
4. Some routes appear to have three transit centers with what appears to be timed transit at each, such as Wake Medical to Crabtree Valley Mall (page 63), the ends evidently both transit centers, with Raleigh Duke Hospital, also a transit center, mid-route, and perhaps also North Hills, another transit center, which would also be mid-route. Also, this route is shown with 67.5 minutes for each one way trip, operated at 30 minute headways – with four buses; which is mathematically impossible. This type of scheduling can be very problematic, as this bus must hit three, perhaps even four, different critical time points with no more than a few minutes variance, and the exact minute must be one that also works for the two, three, or even seven (Crabtree Mall) other buses that must be scheduled to hit that point at the same time. This is not necessarily impossible, but, at a minimum, it is difficult, and will likely require some route changes from the original concepts, even if the travel speed shown – 12.8 mph – is possible – which we are not yet convinced it is.

- **Bus size may be too large.**

Another consideration is the type of bus to be utilized. Given the cost per bus in the Plan and Spreadsheet – $396,000 in FY12 dollars[126] – it appears that most, if not all, of the buses to be purchased will be standard 40-footers with approximately 40 seats. While, undoubtedly, there will be routes where this full capacity will be needed at the peak load points of the route during rush hours, for many of the expanded routes into more suburban and rural areas, it may be possible to utilize smaller vehicles. There are many options for smaller transit vehicles, down to 15-seat buses, that may be more applicable for many of these routes, and for the rural Wake County bus service with route deviation described on page 30 of the Plan. There are many other considerations in determining the best fleet mix, so our observation here is that this should be carefully studied, if it has not already been.

- **Triangle Transit bus fleet will evidently be r*educed o*ver the long term.**

The Spreadsheet show the Triangle Transit bus fleet expanding by 16 buses during the three-year period, FY13-FY15[127], from 67 total and 56 peak buses at the end of FY10[128] (as Triangle Transit has significant operations outside of Wake County, it should not be assumed that all of the 2010 vehicles were used exclusively for Wake County bus service). However, over the next fifteen years (FY16-FY30), the fleet is *reduced* by one to three buses each year, with a FY13-FY30 total net change of a six bus *reduction* from the implementation of the Plan[129].

The reduction, at least in the first years, cannot be explained by the start-up of commuter rail service replacing some of the long-haul commuter express bus services that Triangle Transit operates, as the first year of commuter rail service is shown as FY20[130], four years after the bus fleet reduction program begins – in fact, eight of the sixteen buses that are added between FY13 to FY15 are eliminated from FY16 to FY19[131], before commuter rail begins.

An explanation of this pattern of bus fleet growth, immediately followed by bus fleet reduction prior to the commencement of commuter rail service, would appear to be in order. We suggest that the timing of such changes in bus fleet also be reconciled to our previous comments on the time required to procure and place new buses in service, where we project that it will be approximately July 1, 2015 before any new service is operated with newly purchased buses, rather than the April 1, 2013 assumed in the Plan.

- **New vehicle registration fee, and rental vehicle tax, to support transit, which will provide no benefit to drivers.**

To some taxpayers, charging private vehicle owners to support transit may appear to be a disconnect between those that are paying the cost and those that receive the benefits. While this would hardly be the first such instance where drivers have been charged to support transit, given that transit provides virtually no direct benefit to drivers, in their role as drivers, particularly

[126] Spreadsheet, "Bus Srvcs – System Unallocated" tab, cell K34.
[127] Spreadsheet, "Bus Srvcs – Expand – TT" tab, cells L15-N15.
[128] NTD 2010, Triangle Transit "profile."
[129] Spreadsheet, "Bus Srvcs – Expand – TT" tab, cells O15-AC15.
[130] Spreadsheet, "Rail Project – TMC to Garner" tab, cell S106.
[131] Spreadsheet, "Bus Srvcs – Expand – TT" tab, cells O15-R15.

when there is no shortage of local road improvement projects that lack funding[132], this shift may be questioned by the drivers who are paying the higher fees.

It is understood that transit has not been supportable by user charges in the U.S. for decades, with only slightly over 20% of transit capital, operating, financing and other costs paid by fares and other operating income in 2009[133] and that, without public sector subsidies from taxpayers, transit, as we now understand it in the U.S., would not exist. (While there are a significant amount of papers purporting to show huge taxpayer subsidies for driving, amounting to as much as 30% of gross domestic product[134], when such costs as the value of time lost to traffic delays are excluded, and all levies to auto users for auto use, including payments that are not dedicated for road use, are considered as road user charges, roads charges appear to cover expenditures on roads[135].)

It is also understood that North Carolina local governments have limited possibilities for funding transit programs and that the State Legislature has specifically made sales taxes, vehicle registration fees and rental vehicle taxes accessible for transit funding purposes. That said, there is still a lack of logic in forcing road users to finance transit, which provides them virtually no benefits, while there are many major unmet road needs.

- **Vanpool has been, by far, the most cost-effective mode of transit service in Wake County, and the lowest cost to the taxpayers, but there is no mention of vanpool in plan.**

Of the three current Wake County transit modes (motor bus, demand responsive, and vanpool) vanpool in many respects is the most cost-effective. It has the lowest subsidy per passenger-mile – $0.13, compared with $0.74 for motor bus and $2.15 for demand responsive; the highest farebox recovery ratio – 34.9%, compared with 11.9% for bus and 10.6% for demand responsive; and, most interestingly, actually has a far higher average passenger load, 10.5, than bus, at 6.5.

Despite this record of success, the Plan not only does not have any proposal for vanpool program expansion, it does not even mention vanpool other than two simple statements that Triangle Transit is responsive for operating vanpools in the area. Vanpool can be an extremely effective methodology for providing certain types of transit service, particularly long-distance travel for specialized groups such as employees of a specific employer, but it is surely not the universal transit model, and there are many transit situations where it simply will not be very useful. Given the clear record of success of vanpool transit in this area, the low requirement for taxpayer subsidies, and the ease of adding service, it is not understood why the Plan fails to include a vanpool expansion element.

- **The Plan presents fuel usage and cost as a major issue for auto drivers, implying that transit expansion will help address this.**

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[132] Capital Area Metropolitan Planning Organization and Durham-Chapel Hill-Carrboro Metropolitan Planning Organization, *2035 Long Range Transportation Plans*, May 20, 2009, Appendix I, Road Projects List: http://www.campo-nc.us/LRTP/2035/2035JointLRTP_3-24-09_publicreviewdraft_LT.pdf

[133] APTA, *2011 Public Transportation Fact Book*, Table 2, "National Totals, Report Year 2009," page 7: http://www.apta.com/resources/statistics/Documents/FactBook/APTA_2011_Fact_Book.pdf

[134] Sierra Club, *Stop Sprawl: America's Autos on Welfare in 2010: A Summary of Studies:* http://www.sierraclub.org/sprawl/articles/subsidies.asp

[135] Thomas A. Rubin, *Do Highway Users Pay the Full Costs of Roads?*: http://americandreamcoalition.org/

At best, transit is approximately equivalent to automobiles in energy utilization[136], but, because transit in Wake County currently has average passenger loads far below national averages, and the planned transit additions are lower still, Wake County transit expansion is particularly ill-suited as a transportation energy reduction tactic.

In fact, given that the transit industry energy usage per passenger-mile has been *increasing* for years[137], while automobiles have been improving and, under recent Federal requirements to achieve 54.5 mpg by 2025[138], should be substantially improving further, the proposed Wake County transit expansion program will be a negative factor as to fuel usage and CO_2 emissions. This is not to say that transit improvements should never be pursued, of course, because there are non-energy benefits to transit, but this justification for transit expansion in Wake County is false.

- **Cost per Commuter Rail Rider is high.**

The proposed commuter rail system is to have an initial capital cost of $335.0 million and annual operating costs of $7.6 million, expressed in constant FY12 dollars[139]. We have utilized the data in the Plan and Spreadsheet, along with national transit industry statistics and practices, to project annual commuter rail ridership at 375,000. Assuming 255 working weekdays a year when commuter rail will be operated, this is approximately 1,470 trips per day, or approximately 735 people a day making a round trip commute on commuter rail.

Using the Federal Transit Administration's "new starts" costing methodology (capital costs are annualized over the useful life of the assets at a 7% discount rate)[140], and using an overall average useful life for the commuter rail assets of 30 years, this produces a cost per rider of approximately $92[141]. This is equivalent to $184 per day, $920 per week, $3,900 per month, or $47,000 per year. (Note: Because a major portion of the ridership of new fixed guideway transit systems are pre-existing transit users who shift to the new mode, the actual FTA metric is cost per ***new*** rider. We have no information as to the portion of commuter rail riders that may have previously utilized bus, vanpool, or other transit services, so we have no factual basis for computing cost per new rider. It is rare for the new ridership in a corridor with existing transit service, such as this, to approach 50 %.)

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[136] Randall O'Toole, *Does Rail Transit Save Energy or Reduce Greenhouse Gas Emissions?*, April 14, 2008, Cato Policy Analysis No. 615: http://www.cato.org/pub_display.php?pub_id=9325 (Despite the name, bus service is comprehended by the analysis.)

[137] Thomas A. Rubin, "Does Bus Transit Reduce Greenhouse Gas Emissions?", Reason Foundation, April 5, 2010: http://reason.org/news/show/1009762.html.

[138] The White House, "President Obama Announces Historic 54.5 Fuel Efficiency Standard,: July 29, 2011: http://www.whitehouse.gov/the-press-office/2011/07/29/president-obama-announces-historic-545-mpg-fuel-efficiency-standard

[139] Spreadsheet, "Rail Project – TMC to Garner," cells K36-K41.

[140] FTA, "SCC (Standard Cost Category" Workbook," http://www.fta.dot.gov/13070_2580.html. The "cost per new rider" metric was used as the FTA "new starts" grant cost-effectiveness metric for many years, but, in the early 2000's, it was replaced by "cost per user benefit," which is basically the cost of a hour of travel time saved. The computation of the new metric requires the application of highly sophisticated transportation models by expert planners, and we do not have either the model or the time to do this calculation. "Cost per new rider" is still reported to FTA by all "new grants" grant applicants and, although not a formal part of the evaluation process, is widely utilized by many parties at interest in such evaluations. FTA has proposed (Jan. 30, 2012) to change again its use of these measures in evaluating 'New Starts' applications.

[141] $335 million x .0806 (FTA-specified annualization factor for 30-year assets) ➔ Annualized Capital Cost of $27.0 million + Annual Operating Cost of $7.6 million ➔ Total Annualized Cost of $34.6 million divided by 375,000 annual boardings = $92.27 annualized cost/boarding.

Even if there were 1,470 ***new*** riders, the $92 cost per new rider would be extraordinarily high for a Federal 53 USC 5309 "new starts" grant applicant and, given the intense competition for such grants, the likelihood of success without substantial changes would appear questionable.

A standard comparison is to compare the cost per (new) passenger to what it would cost to provide each (new) rider a car (in fact, one of the reasons why the FTA cost-effectiveness metric was changed from cost per new rider is that many proposed transit improvements did not compare well when this was done). Often, the cost per new rider would cover the cost of used compact car and its operating costs, sometimes more expensive vehicles. We will not bother to calculate what type of vehicle could be provide to commuter rail users for an annual lease, maintenance, insurance, fuel, registration, and other costs of $47,000 a year; the point is obvious.

- **The Plan uses one-mile radius around commuter rail stations as a ridership catchment area, but does not discuss in detail the process of how users could get from the station to jobs that distance away.**

The Plan discussion of Commuter Rail[142] has a number of interesting elements, beginning with the projection of the number of jobs, current and projected for 2035, within a one-mile radius of the stations. In particular, for "Raleigh Downtown," which includes, but is not limited to, the Raleigh central business district and North Carolina State Capital Complex, growing from 14,600 to 79,010 jobs will require the creation of well over four times as many jobs in the next 23 years than were created in the 220 years since Raleigh's founding in 1792. The 14,600 "current jobs" are 3.0% of the total 2010 480,279 Wake County jobs shown on page 18, but the 79,010 2035 jobs would be 11.0% of the total projected 2035 718,593 jobs – or $3^{2}/_{3}$ the current proportion. This would be truly remarkable in an era when downtown business districts have struggled to even retain their number of jobs and most have lost significant job share.

For all of these expected jobs to be accessible for commuter rail commuters, we run into the transportation problem known as, "the last mile" – OK, these people have arrived at the station, but their jobs, or other destinations, are up to a mile away (well, actually, in terms of access distance, it can be further – if we assume a perfect grid system of streets laid out along North-South, East-West lines, a point one mile Northeast of the station would require covering 1.4 miles to reach, 0.7 mile East and 0.7 mile North – and the street network around the Wake and Durham County stations are far from a perfect grid, which will make some of those one-mile radius trips even longer walk distances).

For decades, the standard rules of thumb for transit catchment area walk distances has been one-quarter mile for bus stops and one-half mile for rail stations; these are useful, but far from perfect for all purposes and for all transit systems[143]. However, it is very clear that the walk access distance drop-off becomes very large as distance increases – particularly on those days when there are high and heat and humidity, rain, or other less than ideal weather conditions. Some commuter rail operators, notably Caltrain on the San Francisco Peninsula, have been very successful in promoting bring-your-bicycle-on-board commuting for their patrons[144], but, for the

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[142] Plan, p. 17-18.

[143] Erick Guerra, Robert Cervero, and Daniel Tischler, "The Half-Mile Circle: Does It Best Represent Transit Station Catchments?," July, 2011, Institute Of Transportation Studies, University Of California, Berkeley, Working Paper UCB-ITS-VWP-2011-5:
http://www.its.berkeley.edu/publications/UCB/2011/VWP/UCB-ITS-VWP-2011-5.pdf

[144] Caltrain, "Bicycles:" http://www.caltrain.com/riderinfo/Bicycles.html

vast majority of riders, there will have to be other provisions made – particularly since the station site is some distance from the center of employment in downtown Raleigh and, therefore, there is a high percentage of commuter rail riders that will have travel distance to their destinations well over half of the one-mile-as-the-crow-flies radius.

The downtown Raleigh access problem is further complicated by the proposed Raleigh commuter rail station being several blocks away from the downtown Raleigh transit center at Moore Square Station – which is located where it should be, close to the current center of downtown trip generators. This means that the use of existing and planned general-purpose bus routes as commuter rail collector/distributors is far less practical; the commuter rail station will have to become the secondary bus terminal for its specialized distributor and collector bus routes, and likely selected general-purpose routes as well (although the Plan makes no mention of bus access at this station, unlike most of the other commuter rail stations[145]). Some of the other commuter rail stations will have similar issues.

The Plan states (page 18), *"The representative governments at each commuter rail stop have committed to having established or establishing within five years an effective network for transportation employees to job sites."* This is a necessary and proper step to give commuter rail a reasonable chance at success – however, the implication of this statement is that the costs of such networks are not included in the Plan and, presumably, would have to either be folded in at some later date or other financing arrangements made. Also, "committed to" is not the same as, "agreement finalized."

With the total expected commuter rail daily ridership of 735 in the morning and 735 more in the afternoon, one begins to question how much resources should be devoted to solving the "last mile" transportation problem of these riders, even if every single trip will begin or end in downtown Raleigh (which is exceedingly unlikely). With 1,470 daily total trips and twelve stations, the average boardings-plus-alightings per station per day will be 245 and, with downtown Raleigh expected to have the largest share by a wide margin, some of these stations will likely be dealing with fewer than 100 over the course of the entire day.

- **Light Rail ridership cost per rider is also high.**

The proposed light rail system is to have an initial capital cost of $1,116.5 million and annual operating costs of $15.265 million, expressed in constant FY12 dollars[146]. We have utilized the data in the Plan and Spreadsheet, along with national transit industry statistics and practices, to project annual light rail ridership at 3,184,000. Assuming the FY10 CAT annual-to-working weekday ridership ratio of 321.8-to-1[147] is applicable for light rail, this is approximately 9,900 trips per day, or approximately 4,450 people a day making a round trip commute on light rail.

Again applying the FTA "new starts" costing procedure, the annualized total cost per light rail passenger would be approximately $33[148] per rider. This is equivalent to $66 per day, $331 per week, $1,405 per month, or $16,900 per year for a Monday-Friday, home-to-work round-trip rider. Again, this is cost per ***total*** rider, ***not*** new rider. For corridors such as this, the

[145] Plan, Appendix D, "Proposed Commuter Rail Route and Station Locations," pp. 113-114.
[146] Spreadsheet, "Rail Project – DtCary to Millbk," cells K36-K41.
[147] NTD 2010, "Profile."
[148] $1,116.5 million x .0806 ➔ Annualized Capital Cost of $90.0 million + Annual Operating Cost of $15.265 million ➔ Total Annualized Cost of $105.3 million divided by 3,184,000 annual boardings = $33.07 annualized cost/boarding.

new riders are generally no more than approximately 40% of total riders, often far lower. $33 per ***new*** rider would generally not be a competitive value for a light rail project of this type, but, given the likely ratio of new to pre-existing riders, the likely value for cost per new rider would be much higher and, very likely, far outside of the usual competitive range.

We also question even this ridership projection, which was based on the Plan assumption of a 20% farebox recovery ratio, which appears to be an arbitrarily selected value, not based on any transportation modeling or other expert analysis. We note that the working weekday light rail ridership of 9,900 would be ***over half*** (56%) of the reported FY10 CAT total ridership, bus plus demand-response, of 17,537 – a relationship that we have never previous encountered[149].

Again, we will not attempt to show the type of automobile that could be provided to each (new) rider for $16,900 per year.

- **Although not stated, ridership projections can be made from Plan statistics**

The Plan and Spreadsheet provide virtually no explicit data on ridership, which makes it difficult and frustrating to attempt to relate the projected costs of the proposed new taxes, and the expenditures in the Plan, to quantified transportation and other benefits. There are, however, various assumptions and projections in the Plan and Spreadsheet that, together with selected statistics from existing Wake County transit operators and national transit industry data, allowed us to make some reasonable projections of the usage of the proposed transit system expansions. We computed costs per unit of transit service consumed. In order to make these comparisons more meaningful, we will produce cost statistics in constant fiscal year 2010 (FY10) dollars.

We have critiqued many of the assumptions and the model logic of the Plan and Spreadsheet as being unrealistic; however, in this regard, they make these calculations far simpler:

- There is a single inflation value for each year, used for all purposes; fare revenue, operating costs, and capital costs. Further, the value is 1.5% annually for each year from FY07 through FY15 and 3.1% annually for each year from FY16 through the end of the *Plan* period in FY40[150].
- With one exception, each year of operations of each mode is identical to all other years for that mode. The first year of service for each is a full year (again, with one exception), starting on day one of the year, and all dollar values, all costs, all fare revenues, and all subsidies are identical in each year after they are converted to constant dollars. Since the fare revenue is identical each year in constant dollar terms, it can be assumed that ridership is identical in each year (extremely unrealistic, but that is what is in the Spreadsheet, so that is what we will work with).
- The sole exception to the above is the additional bus service, which increases each year from the first year of service in FY13 to FY25, when the bus fleet reaches its maximum level, and then each year from FY25 to FY40 is identical in constant dollar terms. During the ramp-up period, the only real difference is the number of vehicles operated; the costs of operations, the ridership, the fare revenue, the capital costs of

[149] By comparison, Charlotte's light rail (LYNX) ridership was 15.6% of total CATS ridership for 2010. (NTD 2010, "Profile" for CATS.)
[150] Spreadsheet, "Assumption Summary" tab, rows 120-128.

the vehicles, and the sources of subsidies are all identical on a per-vehicle basis[151]. In the first year of service, FY13, there will be only three months of operation[152].

Since the bus service reaches its maximum level in FY25, commuter rail service begins in FY20[153], and light rail service begins in FY22[154], we will use FY25 data for all three modes to perform our analyses.

In the following, where there is data, an assumption, or other documented actionable item in the Plan and/or Spreadsheet, we utilize it, even if we believe it is questionable. Where such is not available, we rely on actual data from Wake County transit operators and from the national data for the various modes from reliable sources, chiefly the U.S. Department of Transportation/ Federal Transit Administration's National Transit Database (NTD), and on standard transit industry practices.

- **Motor bus ridership projections**

Motor bus service, as described in the Spreadsheet, does have some useful data on ridership. Specifically, there is value provided for passenger-miles per peak bus per year, 184,626[155]. Since the spreadsheet also presents the number of peak buses for each year[156], it is a simple matter to multiply the number of passenger-miles per bus per year by the number of peak vehicles to produce bus passenger-miles for each year[157].

The next step is to work from passenger-miles to unlinked passenger trips. For the FY10 NTD reporting year, the three bus transit operators that are shown with service expansions from the Plan revenues, CAT, C-Tran, and TT[158], had an average overage average trip length of approximately 5.4 miles. We assumed that this FY10 statistic would be applicable for the added service, and dividing passenger-miles by average trip length produces *unlinked passenger trips, 5,812,000 per year*. Finally, we can derive average fare per passenger-mile by dividing total bus fare revenue by passenger-miles. For FY25, bus fare revenue – calculated by applying the 15% bus farebox recovery ratio assumption (which we question) – is $7.796 million[159]. Dividing this

[151] *Ibid.* "Bus Srvcs – System Unallocated" tab.
[152] *Ibid.*, "FTA 5307 Grant Revenues" tab, cell L14.
[153] *Ibid.*, "Rail Project – TMC to Garner" tab, cell S89.
[154] *Ibid.*, "Rail Project – CtCary to Millbr" tab, cell U89.
[155] *Ibid.*, "FTA 5307 Grant Revenues" tab, row 31.
[156] *Ibid.*, row 20.
[157] *Ibid.*, row 32. Although the Spreadsheet clearly shows that there will only be three months of bus service in FY13, just below where that assumption is presented, the calculation of passenger-miles for that years ignores this and calculates a full year's worth of service for the buses placed into service in that year (cell L32). Although this is clearly an error (this service would have to begin over four months prior to the election where the voters will decide on the proposed new taxes), we followed the process in the Spreadsheet and show a full year's worth of bus passenger-miles in FY13; which means that the fare structure for the added bus service will be in place on July 1, 2012. We have commented that we believe a more realistic commencement date for bus service is July 1, 2015, the beginning of FY16. Therefore, by following the above, we are including what we believe is three full years of service that will not be operated.
[158] There are no references in the Plan or Spreadsheet that indicates that any of the Plan expenditures will be for North Carolina State University Wolfline purposes, so we use data for only the other three operators, which are specifically identified as receiving significant funding for service expansion in the Plan, as our base for comparison to expanded service.
[159] *Ibid.*, "Combined Transit Summary" tab, cell Y22.

by FY25 bus passenger-miles of 31,386,347[160] produces an average fare per passenger-mile of $.2483 in FY25 dollars. Deflating this back to FY10 dollars using the inflation factors in the Spreadsheet produces a FY10 dollar average fare per passenger-mile of $.1715. *This is approximately 54% higher than the actual average fare per bus passenger-mile for FY10 for these three operators*, at $.1115[161] and about 53% lower than the 2010 national average fare per bus passenger-mile of $.2394[162].

To translate the average fare per passenger-mile for the added bus service of $.1715 into average fare per unlinked passenger trip, we multiply it by the FY10 actual trip length of 5.426 miles[163] and get $.9306.

- **Light Rail ridership projection.**

For our light rail calculations, we begin with the assumption that the light rail fare structure will be identical to that of bus; namely, the $.9220 per boarding in FY10 dollars, as is the norm in the U.S. transit industry for bus operators adding light rail service. Then it is a simple matter of taking the light rail farebox revenue for each year[164] ($4.332 million for FY25), adjusting it to FY10 dollars ($2.963 million), dividing by our FY10 average fare per boarding above, and we have *3.214 million light rail boardings per year*.

To calculate light rail passenger-miles, we went to the NTD data for FY10 and found that the national average light rail trip length was 4.76 miles[165]. Although bus trips in Wake County are longer than the national average, this is a relatively short light rail line (13.9 miles[166]), so we will go with the national average as our assumption. Multiplying the annual boardings of 3.214 million by this factor produces annual light rail passenger-miles of 15.300 million (slight difference due to rounding).

Using the national average cost per LRT Vehicle Revenue Hour for 2010 – $248.40[167] – as our baseline, we then increased this by the Plan inflation assumption for each year[168], calculated annual LRT vehicle revenue hours, multiplied that by the average operating speed above, and calculated 1,776,744 LRT vehicle revenue miles per year. Dividing passenger-miles by this value produces an average passenger load (APL) of 8.6.

Size and number of seats vary for light rail vehicles, but a typical 90-foot light rail car generally has approximately 75 seats, so the 8.5 average passenger load would be an annual average utilization factor, seats, of about 11%. Light rail cars are wider than buses, generally have four door areas per car with additional standing space, and are designed to operate with high standing loads at the peak load points. A peak load point capacity of 125 is common for light rail scheduling, and the 8.5 APL would be 7% of that. The 2010 national average light rail

[160] Spreadsheet, "FTA 5307 Grant Revenues" tab, cell Y32. (Row 32 in this tab is mislabeled as "Revenue Miles for Total Accumulated Bus Fleet.") Cell Y32 is a calculation, "Y31*Y20," which is "Bus Incentive – Passenger-miles – Input," which is the annual passenger-miles per bus, times "Expanded Bus Service Project – Acc. Bus Fleet," which is the number of buses in operation for each year.)
[161] Authors' calculation from data in NTD 2010, "Profiles" for the three named bus operators.
[162] Authors' calculation from data in NTD 2010 "Fare Revenue Earned by Mode" and "Service" tables.
[163] Authors' calculation from data in NTD 2010, "Profiles" for the three named bus operators.
[164] Spreadsheet, "Rail Project – DtCary to Millbr" tab, row 86.
[165] Authors' calculation from NTD 2010, Service table.
[166] Plan, page 26.
[167] NTD 2010 total LRT operating costs of $1,521.931.165 (Operating Expense table) divided by total LRT vehicle revenue hours of 6,126,942.
[168] Spreadsheet, "Assumption Summary" tab, row 126.

passenger load was 23.7[169], so the proposed Wake County light rail line would be at approximately 36% of that.

- **Commuter Rail ridership projections**

Commute rail transit trips have, historically, been both longer and faster than most other forms of transit, generally serving more affluent suburbs, and providing what, in transit terms, can be described as premium service at a premium price. Therefore, our approach to projecting commuter rail service consumption had to be modified from what we did for motor bus and light rail.

We begin our projection by comparing the average fare per boarding for commuter rail and motor bus for 2010, $4.0594 and $.9581[170], respectively, which produces a ratio of commuter rail to motor bus fares of 4.237:1. We then multiplied this ratio by the average Wake County bus fare per boarding of $.9220 to produce a projected average commuter rail fare per boarding of $3.943 in FY10 dollars. We divided the constant dollar total fare revenue ($2.160 million[171] in FY25 dollars ➔ $1.478 million in FY10 dollars) by this value and we obtain *annual commuter rail ridership of 0 .378 million trips.* We then returned to the NTD data and divided national total passenger-miles by unlinked passenger trip and produced an average commuter rail trip length of 23.423 miles[172]. We multiplied that by the annual boardings and produced annual commuter rail passenger-miles of 8.861 million (slight difference due to rounding).

Using the process described above for light rail, we computed an average passenger load of 12.8. Commuter rail vehicles vary significant in size, configuration, and seating, but the overall average for 2010 was 113[173] – interestingly, once again, producing the same 11% average annual seat utilization. The 2010 national average for commuter rail was 34.2[174], so the Wake/Durham County commuter rail service would be approximately 63% below that.

- **Impacts on existing ridership**

As discussed above, the calculated FY10 dollar bus average fare per bus boarding on the proposed added bus service will be over 54% higher than the actual average bus fare for that year. As a practical matter, it would be most difficult to have different fares for the pre-existing and the proposed new transit services, particularly since a major component of the added bus service will be on existing bus lines, extending them in length, shortening headways, and adding days and/or hours of service. Therefore, for the $.93 (FY10 dollars) fare to be in place for the added service, it would appear that there is no alternative to making it the fare for all bus service, beginning when the added bus service goes into effect, as discussed above, on June 1, 2012.

As long experience in the transit industry – as in almost every industry and market sector – has shown, when the price of something goes up, consumption generally goes down, all else equal. The question then becomes, how much? In his classic paper on fare elasticity, reporting on research originally performed for New York City in the late 1940's when it was considering a fare increase, John Curtin[175] of Simpson and Curtin showed the results of his survey of the

[169] Author's calculation from NTD 2010, "Service" table.
[170] Authors' calculation from data in NTD 2010 "Fare Revenue Earned by Mode" and "Service" tables.
[171] Spreadsheet, "Rail Project – TMC to Gardner" tab, cell X86.
[172] Authors' calculation from data from NTD 2010, Service table.
[173] Authors' calculations from data from NTD 2010, "Revenue Vehicle Inventory" table.
[174] Author's calculation from NTD 2010, "Service" table.
[175] John F. Curtin, "Effect of Fares on Transit Riding," *Highway Research Record*, 213 (1968), pp. 8-19.

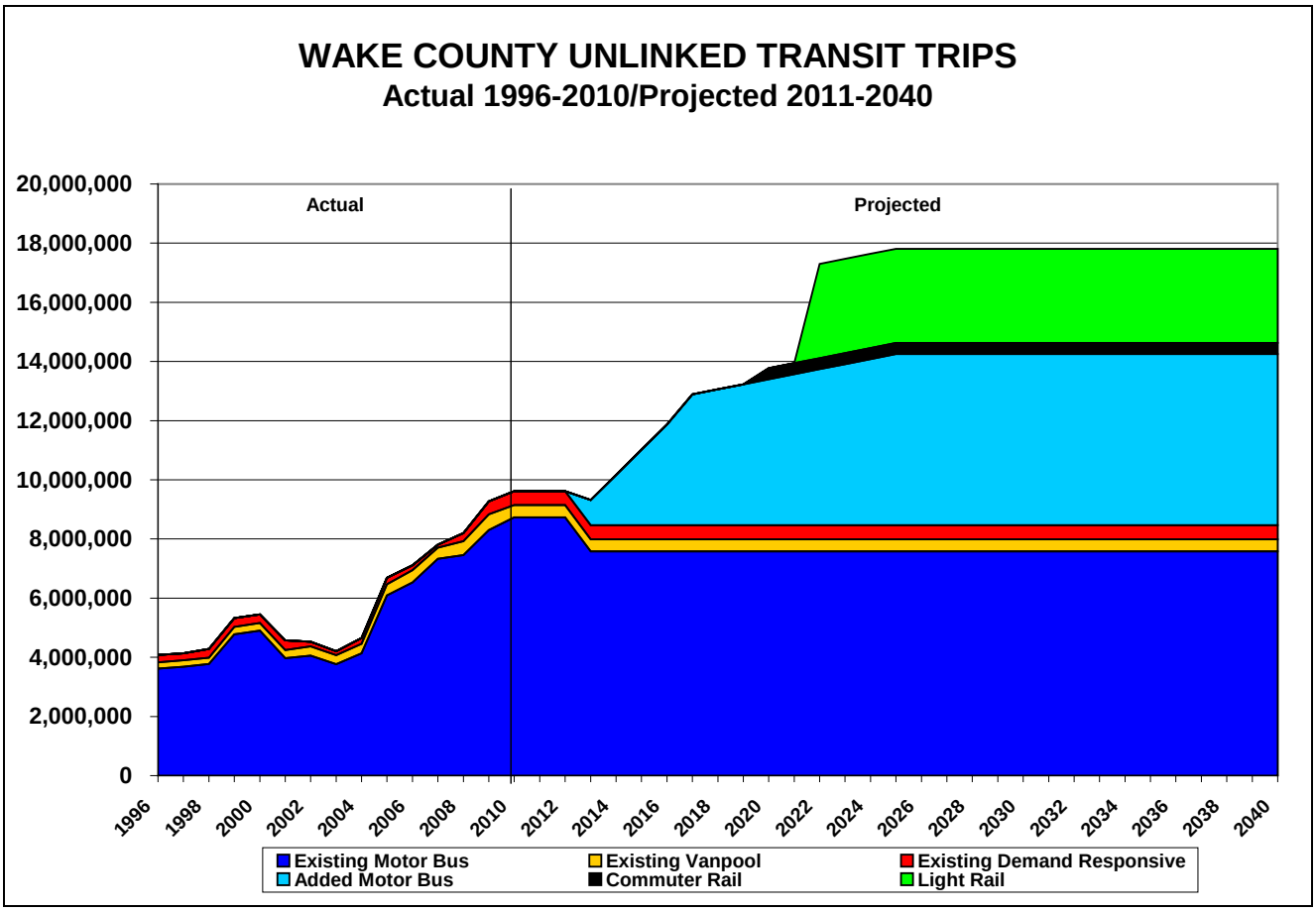
impacts of fare increases, which produced an overall fare elasticity of -.33 – or, roughly, for every 3% increase in fares, ridership will decline 1%. This has been widely known as the "Simpson-Curtin Formula" ever since. A mega-survey publication[176], based on analysis of fare changes and their impacts for 52 transit systems, by the American Public Transportation (*nee* Transit) Association, while pointing out that there were a variety of different factors that had to be considered in ridership projections for fare changes, and that elasticity's vary by size of the community served, time of day, etc., actually produced a table of elasticity's that were not very dissimilar to the Simpson-Curtin Formula; -40 for all cities, all hours, and -.43 for systems in urbanized area with less than one million population.

We have neither the time nor data to attempt to perform a detailed quantification and projection of the impacts of a major fare increase in Wake County so, for simplicity's sake, we will apply the Simpson-Curtin formula – an increase of 54% in average fare would produce a reduction in boardings of 18%. Applied to the 6,470,669 FY10 motor bus boardings[177] for our three bus systems, there would be a reduction in ridership of approximately 1.165 million.

Although demand-responsive fares are generally directly tied to bus fares, we decline to project ridership reductions due to fare increases for this mode.

Figure A2: Graph of Historical and Projected Future Transit Ridership

[176] Jim Linsalata and Larry H. Pham for APTA, *Fare Elasticity and Its Application to Forecasting Transit Demand*, August 1991.
[177] NTD 2010, "Profiles" for these three operators.



- **Conclusion regarding ridership projections**

In constant FY10 dollars, the proposed transit expenditures in the Plan (exclusive of the remaining cash balance at the end of the period) are $3.381 billion dollars and the ridership increase is 209.6 million unlinked passenger trips and 1,239 million passenger-miles[178] over the period 2013-40 (not adjusted for the projected loss of 1.165 million pre-existing bus riders per year due to the fare increase, either for the change in transit usage or for the cost savings due to less transit service being operated due to fewer riders). As previously stated, we find many of the assumptions underlying these projections to be questionable. Relating these costs and benefits to that reported for the three FY10 Wake County motor bus operators that will receive funding to increase bus service during the Plan period, we present the following comparison:

	Existing Operators[179]	....Plan[180]….	Plan as % of Existing
Cost per Unlinked Passenger Trip	$ 4.38	$16.13	368%
Cost per Passenger-mile	$ .81	$ 2.73	337%

[178] Authors' calculations, as described above.
[179] Authors' calculations from data from NTD 2010, "Profiles" for these three operators.
[180] Author's calculations.

Costs include both operating and capital costs and Plan costs include cost of financing (existing service has none). For both, costs of assets that have useful life beyond the period are included; no effort has been made to quantify these.

- **"Choose how you move" transit travel times are significantly longer than auto travel times**

The *Wake County Transit Plan* contains seven vignettes included to illustrate the tag line of the Plan, "*choose how you move*." Each vignette presents an origin-destination pair with three or more scenarios, all but one including at least two transit options, most proposed to be newly provided in the Plan, versus driving. Oddly, nowhere in each vignette, or elsewhere in the Plan, is there any comparison of the travel times for each scenario, so we have used the best available information to develop our own. One of the vignettes proved very difficult to analyze, so we split it into two, for a new total of eight vignettes to be analyzed.

In every single case, driving was significantly faster. The simple average of increase in clock time of the 27 individual transit scenarios over the driving clock time was 127%; with the application of the "perception" that wait and walk times appear longer than the actual clock time is applied, the simple average was 147% longer than driving. The best transit options were, on average, 43 minutes longer in clock time and 55 minutes longer in perceived time.

The best single match-up for transit was a 39-minute clock time, 19% disadvantage involving an Amtrak trip to Charlotte – which is intercity rail, not transit. The best "pure" transit match-up was two scenarios that involving driving to park-and-ride lots, at 46% clock time disadvantages (in every case where there was a drive to a park-and-ride lot scenario, it was the best transit option). Seven of the 27 had clock time disadvantages of at least 150% (two-and-one-half-times as long), with the worst being a 382% disadvantage (almost five times as long) for a local-bus-to-express-bus-to-shuttle-bus trip from North Raleigh to a Research Triangle Park worksite. For three of the eight vignettes, there was no transit scenario that was less than double the drive clock time.

Overall, it is very difficult to conceive why most people would consider almost any of the transit options laid out in these vignettes as attractive in any way if they had an auto available to them for the trip being discussed and time was at all a factor of importance.

We have analyzed each vignette, and each scenario, to calculate their actual travel times. Wherever possible, we have utilized the actual travel times in the Plan. Where there are not directly applicable times in the Plan, we utilized travel times provided by the existing transit operators' web sites' schedules and/or travel planners. Where this was not possible, we performed our own calculations based on other applicable data from the Plan or the travel planners, such as using an end-to-end travel time for a proposed new bus route in the Plan, plus the travel distances for the entire new route and the distance actually traveled on that route in the scenario, adjusted by other factors that may impact travel time, to approximate a trip for less than the entire length. We also included the time requirements for transit access, including accessing the first transit vehicle via walking, cycling, or driving, consistent with the details of each scenario within each vignette; wait times at the stop or station for the transit vehicles to arrive; transfer access and wait times; and travel times from the last transit vehicle (or automobile parking for the "drive" scenarios) to the ultimate destination. Where the Plan does not provide specific details, such as specific origin and destination points, we specified ones that are intended

to be compliant with the descriptions in each vignette. For driving times, we utilized a standard travel time software program, Microsoft® Streets & Trips.

Throughout our analysis, we went to great lengths to give transit every benefit of the doubt, including:

- For most transfers, we specified a one-minute travel time between when the first vehicle is exited to reaching the boarding point for the second vehicle and a four-minute wait time; we believe that these are highly optimistic in many cases.
- Streets and Trips® is well-known to assume travel speeds that are low for automobiles and high for buses; for example, the assumed speed on limited access roads, such as Interstate Highways, is approximately 61 mph (which is not recommended on North Carolina roads of this type for public safety reasons).
- We utilized the "old" urban walking speed standard of four feet per second[181], or approximately 2.75 mph, which is now considered on the high side[182].
- We used a bicycle travel speed of 10 mph, which is also considered optimistic[183]. We added one minute at the beginning and end of each bike-to-bus and bus-to-bike unlinked transit trip for putting the bicycle into the bicycle rack at the beginning of the trip and taking it out at the end, and similar minute additions for rail for similar reasons.

We calculated and presented both "clock" and "perceived" time for all scenarios. It is well accepting in transportation demand planning and modeling that travelers make mode decisions in large part on travel time and that they consider time spent not in motion (such as waiting for a transit vehicle), or walking, as considerably longer than actual clock time; a factor of 250% (a wait time of ten minutes clock time is perceived as 25 minutes) is common[184]. We applied this to all wait and walk times, including those for t he "drive" scenario trips for walk travel between parking and the final destination. We also added the impact of delay caused by congestion. For 2010, the Texas Transportation Institution reported a Travel Time Index (TTI) of 1.14 for Raleigh-Durham. TTI is defined as: "*A measure of congestion that focuses on each trip and each mile of travel. It is calculated as the ratio of travel time in the peak period to travel time in free-flow. A value of 1.30 indicates a 20-minute free-flow trip takes 26 minutes in the peak*[185]*."* In order to show the effectiveness of transit as a traffic congestion mitigation tool, we increased the TTI for our comparison 50%, to 1.21, which we believe is high for future travel

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[181] 4.0 fps dates back at least to the 1988 *Manual on Uniform Traffic Control Devices* (MUTCD), but has generally been toned back to 3.5 fps for most purposes; see 2009 MUYCD, page 497, footnote 07: http://mutcd.fhwa.dot.gov/pdfs/2009/mutcd2009edition.pdf

[182] Richard L. Knoblauch, Marin T. Piertrucha, and Marsha Nitzburg, "Field Studies of Pedestrian Walking Speed and Start-Up Time," *Transportation Research Record 1538*: http://www.enhancements.org/download/trb/1538-004.PDF

[183] Pablo Jensen, Jean-Baptise Rouuier, Nicolas Ovtracht, and Céline Robardet, *Characterizing the Speed and paths of Shared Bicycles in Lyon*, (abstract): http://arxiv.org/ftp/arxiv/papers/1011/1011.6266.pdf

Average speed of 14.5 kph (9.0 mph); this value is for shared bicycle paths, which are generally considered to offer the opportunity for higher operating speeds than conventional on-street bicycle operations.

[184] See, for example, Edward A. Beimborn, "A Transportation Modeling Primer," updated June 2006, page 14, "Out-of-vehicle time is used to represent "convenience" and is typically multiplied by a factor of 2.0 to 7.0 to give it greater importance in the calculations." http://www4.uwm.edu/cuts/utp/models.pdf

[185] David Schrank, Tim Lomax, and Bill Eisele, *TTI's 2011 Urban Mobility Report*, September 2011, "Performance Measure Summary - Raleigh-Durham NC;" http://mobility.tamu.edu/files/2011/09/ralei.pdf.

in Wake County, assuming reasonable attention to road maintenance and expansion consistent with changes in travel patterns, consistent with what is proposed in the areas' *Long Range Transportation Plans*[186]. This factor is applied to motorized road vehicle travel times (automobiles and buses), but ***not*** walking, bicycle, or rail travel[187] times, or for wait times. We applied this factor consistently to all motorized road travel in all scenarios in all vignettes, even though traffic delays are always inconsistent by corridor in any urban area.

In every case, driving was significantly faster than transit, no matter which time metric is utilized for the comparison. This does not necessarily mean that all the additional time for transit travel is "wasted," however. For example, some people are able to use their time on buses or trains to read, text, check e-mail, or even sleep. For the Amtrak trip to Charlotte, spreading out with a laptop and source materials and working on a report or spreadsheet may be feasible.
We make no judgment as to productivity of travel time; we simply report what our research and calculations produced, and each reader can draw their own conclusions as to what means of travel would be preferred.

1. Vignette I (Plan, p.3): *Fuquay-Varina to downtown Raleigh*:
Drive to Fuquay-Varina or Wake Tech park-and-ride, bus to downtown Raleigh.

We selected an origin point South of Fuquay-Varina and the Raleigh destination point as the North Carolina State Capital, producing the following results.

[186] Capital Area Metropolitan Planning Organization and Durham-Chapel Hill Metropolitan Planning Organization, *2035 Long Range Transportation Plans*, May 20, 2009: http://www.campo-nc.us/LRTP/2035/2035JointLRTP_3-24-09_publicreviewdraft_LT.pdf . The CAMPO Conformity Report projects an increase only to 1.13.

[187] While commuter rail is not generally subject to road delay (with the obvious exception of train vs. rubber tire vehicle and/or pedestrian collisions), it can be subject to rail delay. For commuter rail and intercity passenger rail, running on the same tracks as freight rail, there can be significant delays due to conflicts with freight movements, particularly when the host freight railroad has control over train movements.

As we describe below, for the Amtrak Piedmont service between Raleigh and Charlotte, for the most recent Amtrak fiscal year, there was an average delay of 18 minutes on a 178 minute trip between Cary and Charlotte, or 10%, with most of these due to conflicts with freight rail movements. For commuter rail, delays of this number of minutes can be common and are, of course, a far higher percentage of the travel time. (As a side matter, the details of service priorities are an extremely important component of the negotiations of trackage rights for commuter rail services and it can prove to be challenging to gain the types of priorities desired for commuter rail operations – as evidenced by the history of schedule delays for the Piedmont.). Despite these concerns, we have not added any delay factor or time for commuter rail service. Coupled with our concerns that the commuter rail average operating speed in the Plan is overstated, the calculations for commuter rail travel time herein appear quite optimistic.

Table A3: Vignette I Analysis Results

	Drive to Fuquay-Varina, Commuter Bus to Downtown Raleigh	Drive to Wake Tech, Commuter Bus to Downtown Raleigh	Drive
Motorized Travel Time	59	46	33
Walk/Wait Time	10	10	5
Total Clock Time	**69**	**56**	**38**
Additional Perceived Time (additional time that travelers perceive the trip is taking)	15	15	8
Total Perceived time	**84**	**71**	**46**
Additional Delay Time (additional travel time due to traffic congestion)	12	10	7
Total With Delay Time, Clock	81	66	45
Total With Delay Time, Perceived	96	81	52
Transit Extra Time, Clock (transit travel time compared to drive time)	36	21	
Transit Extra Time, Perceived (transit extra time compared to drive time)	44	28	
Transit Extra Clock Time, %	**81%**	**46%**	
Transit Extra Perceived Time, %	**84%**	**54%**	

(Parenthetical notes above apply to all vignettes. Some columns may not sum due to rounding.)

The first scenario is timed using a new route[188], which will include a new "transfer point" transit station, which is scheduled to open no later than 2020[189]. Transfer points are differentiated from park-and-ride lots in the Plan, where they are discussed on the same page, evidently because transfer points, unlike park-and-ride lots, do not provide parking. While Fuquay-Varina is shown on the page with the detailed discussion and listing of transfer points and park-and-ride lots as receiving the former, the vignette specifically states that the travel will be to the "Fuquay-Varina … park-and-ride." We will assume, for our current purposes, that, whatever is actually intended to be constructed, there will be sufficient free parking nearby the Fuquay-Varina boarding point.

The second scenario, Drive to Wake Tech, is timed with an existing bus line, CAT route 40e[190]. The Plan improvements for this will be the addition of a park-and-ride lot at Wake Tech, scheduled to open no later than 2020[191], and the peak headways will be hafted to 30 minutes if the proposed Plan is adopted and implemented.

Driving has a significant time advantage; for a daily round trip, as much as 56 to 88 minutes, depending upon which transit scenario is selected – and the transit scenario that is faster gains its advantage because the transit user drives further before catching the bus to complete the trip.

(Although this is not a travel time issue as such, we will note that parking is always a major issue at all educational institutions, particularly at "commuter campuses" like Wake Tech; therefore, we suggest careful coordination with the School to ensure that parking at the transit

[188] Plan, page 107.
[189] Plan, page 43.
[190] Route 40e – Wake Tech: http://www.raleighnc.gov/services/content/PWksTransit/Articles/CATRoute40e.html
There is a route between the same end points in the Plan (page 80), which had a 30 minute travel time, vs. the 29 minutes for Route 40e. We used the shorter travel time in our calculations.
[191] Plan, page 43.

park-and-ride lot will be available for those who wish to access transit from this location, particularly since the free parking at the park-and-ride lot appears to be one the main factors intended to attract new transit riders who do not wish to pay to park in downtown Raleigh.)

2. Vignette II (Plan, p. 9): *Wake Forest to Holly Springs*

Drive to park-and-ride, commuter bus to downtown Raleigh, express bus to Holly Springs.

We selected an origin near the center of Wake Forest, approximately a mile from the existing Wake Forest park-and-ride lot, and a destination near the proposed Holly Springs transit center.

Table A4: Vignette II Analysis Results

	Drive to Wake Forest Park-and-Ride, Commuter Bus to Downtown Raleigh, Express Bus to Holly Springs	**Drive**
Motorized Travel Time	100	44
Walk/Wait Time	11	0
Total Clock Time	**111**	**45**
Additional Perceived Time	17	0
Total Perceived time	**128**	**45**
Additional Delay Time	21	9
Total With Delay Time, Clock	132	54
Total With Delay Time, Perceived	149	54
Transit Extra Time, Clock	78	
Transit Extra Time, Perceived	94	
Transit Extra Clock Time, %	**142%**	
Transit Extra Perceived Time, %	**173%**	

The first bus trip, from the Wake Forest park-and-ride to downtown Raleigh, is on existing route WRX[192]. The second, from downtown Raleigh to the Holly Springs transit point (scheduled to open no later than 2020[193]), is a proposed new route[194].

In the stem, we have, "*You live in Wake Forest and want to visit your grandchildren in Holly Springs.*" It is a bit difficult to understand why a grandparent would take a trip by transit that is well over an hour longer in each direction, best case – and would seem over three hours longer for a round trip. This is not a matter of the grandparent not having access to an automobile; since the stem has the trip starting with a drive to the park-and-ride lot – and, at the Holly Springs end, since there is and will be little local transit to speak of, we assumed that the grandparent(s) would be met at the stop by his/her son/daughter/son-in-law/daughter-in-law for the last mile to the house. At the current time, the Wake Forest-to-Raleigh express (route WRX) operates five trips in each direction, Monday-Friday only, with the last morning run leaving at 7:55 a.m., perhaps not the most attractive days and times for grandparents to be traveling to see their grandchildren.

[192] Capital Area Transit Bus Routes and Schedules – Triangle Transit Routes Operated by CAT – Wake Forest Express (WRX): http://www.raleighnc.gov/services/content/PWksTransit/Articles/CATBusRoutes.html
[193] Plan, page 43.
[194] Plan, page 109.

It is difficult to imagine many grandparents that would prefer that transit option, perceived as up to almost five hours round trip, vs. spending a perceived hour-and-48 minutes driving, when the approximate three hour time savings could be spent with the grandchildren.

3. Vignette III (Plan, p. 12) ***North Raleigh to Research Triangle Park***

Walk to bus stop, connect to regional express bus to shuttle bus; or drive to park-and-ride, regional express bus to shuttle bus, to Research Triangle Park (RTP) Regional Transit Center (RTC).

For "North Raleigh" – which is not very specific – we selected Branchwater Circle at Scuppernong Place, which is approximately 0.7 mile from a bus stop for new bus route, "Capital Boulevard to Triangle Town Center,[195]" to Triangle Town Center, and then new route, "Triangle Town Center to Research Triangle Park[196]." Bike and Drive distance to Triangle Town Center is approximately 4.6 miles. For the end destination in RTP, we selected South Miami Boulevard at TW Alexander Drive.

The specification in the vignette's second scenario has the bicycle commuter bypassing the first bus route to go directly to the regional express bus, but using the shuttle bus at the destination end. In our experience, many bicycle/transit commuters like to use their bikes at both ends of their transit trip, but we did not modify the specifications in the scenario. If this scenario were modified for the cyclist to skip the shuttle bus, the clock time would increase slightly and the perceived time would decrease slightly.

The same bus route to RTP is utilized in the third scenario, but the commuter drives to a park-and-ride lot, evidently referring to one at Triangle Town Center. There is no transfer point or park-and-ride lot specified at this location,[197] but the map of the route[198] shows a "Major Bus Station" at Triangle Town Center, even though there is no listing of such a station for either commuter[199] or light rail[200], which would go into service no sooner than 2024[201].

[195] Plan, page 49.
[196] Plan, page 101.
[197] Plan, page 43.
[198] Plan, page 101.
[199] Plan, pp. 113-114.
[200] Plan, pp. 115-117.
[201] Plan, route map on page 99, and page 43.

Table A5: Vignette III Analysis Results

	Walk to Bus Stop, Connect to Regional Express Bus to Regional Transit Center, Take Shuttle Bus to Work	Bike to Bus Stop, Connect to Regional Express Bus to Regional Transit Center, Take Shuttle Bus to Work	Drive to Park-and-Ride, Connect to Regional Express Bus to Regional Transit Center, Take Shuttle Bus to Work	Drive
Motorized Travel Time	102	85	112	24
Bicycle Time		30		
Walk/Wait Time	31	13	20	3
Total Clock Time	**133**	**128**	**132**	**27**
Additional Perceived Time	47	20	30	5
Total Perceived time	**180**	**147**	**162**	**32**
Additional Delay Time	21	18	24	5
Total With Delay Time, Clock	154	146	156	32
Total With Delay Time, Perceived	201	165	186	37
Transit Extra Time, Clock	122	114	123	
Transit Extra Time, Perceived	165	129	149	
Transit Extra Clock Time, %	**382%**	**355%**	**385%**	
Transit Extra Perceived Time, %	**451%**	**352%**	**406%**	

The first three scenarios all utilize a shuttle bus from the RTP; there is no such existing shuttle bus service[202], so we assumed that the shuttle bus to be started will go directly from TRP to the end destination site at a speed of 15 mph, which is very quick for a shuttle bus of this type. Transit does not appear to compete effectively for this trip; against a driving travel time of 24 minutes (without any congestion delay), clock time without delay, to 37 minutes, perceived time with delay, the shortest transit trip is almost three times as long and the longest over four-and-one-half times as long. The shortest transit trip is, once again, the one that requires a ten minute drive time (without delays), for a total best case time of 132 minutes. It is difficult to understand why any commuter would use transit, adding over approximately two hours travel time in both directions for a round trip. The free park-and-ride is unlikely to be seen as much of an advantage in this situation, if at all, because free parking in the general rule at RTP job sites.

4. Vignette IV (Plan, p. 31) *Wendell or Zebulon to WakeMed*

B*y express bus, reached by driving to park-and-ride lot, walking, bicycle, or local connecting bus.*

All transit scenarios utilize a proposed new regional bus route[203]. The fourth transit scenario connects to it via a local bus[204], which we assumed will be at the Knightdale park-and-ride, scheduled to open no later than 2020[205].

We selected a trip origin point of West Gannon Avenue/North Pitt Street in Zebulon, approximately 0.8 mile from the start point of the route. This is somewhat longer than the usual

[202] Go Triangle; http://www.gotriangle.org/transit/
[203] Plan, page 105.
[204] Plan, page 69.
[205] Plan, page 43.

maximum walk distance used in transportation modeling, but the stem sets forth two scenarios to get from trip origin to the bus stop, walking and cycling. If we chose a shorter distance, then the distance would be so short as to give no valid reason to cycle; if we chose a longer distance, then walking would be extremely unattractive.

Table A6: Vignette IV Analysis Results

	Drive to park-and-ride, connect to regional express bus to WakeMed	**Walk to bus stop, connect to regional bus to WakeMed**	**Bike to bus stop, connect to regional bus to WakeMed**	**Take local bus, connect to regional express bus to WakeMed**	**Drive**
Motorized Travel Time	54	52	52	47	21
Bicycle Time			7		
Walk/Wait Time	10	19	2	27	3
Total Clock Time	**64**	**71**	**61**	**74**	**24**
Additional Perceived Time	15	29	3	41	5
Total Perceived time	**79**	**100**	**64**	**115**	**29**
Additional Delay Time	11	11	11	10	4
Total With Delay Time, Clock	75	82	72	84	28
Total With Delay Time, Perceived	90	110	75	124	33
Transit Extra Time, Clock	47	54	43	55	
Transit Extra Time, Perceived	57	78	42	91	
Transit Extra Clock Time, %	**165%**	**188%**	**153%**	**195%**	
Transit Extra Perceived Time, %	**175%**	**236%**	**127%**	**278%**	

This is another case where transit simply does not appear very time-competitive with driving; all of the transit options had at least two-and-one-half times the clock time of driving. It is difficult to understand why the last transit scenario is included; rather than taking the faster express bus from Zebulon, the traveler is instead taking the slower local bus from there to a point where (s)he will transfer to the faster bus (this would perhaps be necessary for someone who lived between Zebulon and the transfer point where they could walk to a bus stop where the regional bus did not stop).

5. Vignette V (Plan, p. 32) *Amtrak to Charlotte from Cary*

Access Cary Amtrak station from Apex via walk or bike to bus stop or drive to Cary station.

We chose a trip origin at North Harrison Avenue and Weston Parkway in Apex, about half a mile from the bus stop. The vignette did not specify a destination in Charlotte; we selected the Charlotte-Mecklenburg Government Center, 600 East Fourth Street in downtown Charlotte. For the bike scenario, we biked from the Charlotte Amtrak station to the Government Center, for the others, we used Charlotte Area Transit System route 11.

Table A7: Vignette V Analysis Results

	Walk to bus stop, take bus to downtown Cary, Amtrak to Charlotte	Bike to bus stop, take bus to downtown Cary, Amtrak to Charlotte	Drive to downtown Cary, Amtrak to Charlotte	Drive
Motorized Travel Time	227	219	206	164
Bicycle Time		20		
Walk/Wait Time	50	27	33	5
Total Clock Time	**276**	**266**	**239**	**169**
Additional Perceived Time	75	41	50	8
Total Perceived time	**351**	**306**	**289**	**177**
Additional Delay Time	8	7	3	34
Total With Delay Time, Clock	284	272	242	203
Total With Delay Time, Perceived	359	313	292	211
Transit Extra Time, Clock	81	69	39	
Transit Extra Time, Perceived	148	102	81	
Transit Extra Clock Time, %	**40%**	**34%**	**19%**	
Transit Extra Perceived Time, %	**70%**	**48%**	**38%**	

Because this vignette involved Amtrak, some changes from the local transit methodology had to be incorporated. The bus service to Cary Amtrak station is a proposed line found on page 90 of the Plan. There are three Amtrak departures a day from Wake County to Charlotte. Of these, the most applicable for business purposes appears to be the 6:57 a.m. Piedmont from Cary[206].

Although it is somewhat questionable if the TTI 1.21 delay factor should be applied to intercity driving, we applied it – and, because Amtrak has notorious poor schedule adherence, we also applied a delay factor for this train service. Summing up the monthly delay minutes for the Amtrak fiscal year ending September 30, 2011[207], dividing the 25,614 minutes of delay for the Piedmont by the 1,460 Piedmont trains for that period (two trains a day in each direction for 365 days) and we calculated an average delay per train of 18 minutes. We applied half of this delay (nine minutes) to waiting for the train to arrive and half to in-service delay. Compared to the 34 minutes of delay calculated for the drive-to-Charlotte scenario, we believe that this is being very kind to the transit/Amtrak scenarios.

"Transit" (technically, Amtrak is not transit, it is intercity rail) does comparatively better, by far, against driving in this vignette than any of the others. The extra clock time was only 39 to 81 minutes, which is 19% to 40%, over the drive time, and the extra perceived time only 81 to 148 minutes, or 38% to 70% more.

We could not help noticing that the selection of Apex for the start point meant that this was one of the few parts of the proposed transit service area where the drive to Charlotte would not be primarily on Interstate highways, the drive on a multitude of conventional roads, of 136 miles, took 164 minutes, for an average speed of travel of slightly under 50 mph. If, for example, the trip had begun North or even East of Raleigh, although the drive travel distance would be further, particularly as I-40/I-85 form something of an upward curve between Raleigh

[206] Amtrak, Carolinian/Piedmont schedule, November 7, 2011. http://www.amtrak.com/servlet/ContentServer/Page/1237405732505/1237405732505

[207] Amtrak, *Monthly Performance Reports* for October, 2010-September, 2011, inclusive, "Delay Minutes Performance Reports – Summary," page E-1: http://www.amtrak.com/servlet/ContentServer?c=Page&pagename=am%2FLayout&p=1237608345018&cid=1241245669222

and Charlotte, the speed of travel would likely be far higher. Also, the Amtrak trip would be slower, so the drive option would have a larger percentage advantage.

We will also note that, although the Piedmont trains have been in existence for many years, and Amtrak is subsidized by the State, as well as the American taxpayers, to operate this service, the ridership appears to be a small portion of the total travel between Raleigh and Charlotte. For the eight months, October 2010-May 2011, total Piedmont ridership was 94,155[208], or approximately 387/day, or 194/day in each direction of travel.

We will also note that, for Raleigh to Charlotte service, Greyhound offers departures that are very competitive in time of travel (2:50 for Greyhound vs. 3:10 for Amtrak) and has web fares of $15[209] ($13 for advanced purchase) vs. $27.50 for the Piedmont[210] – and, unlike the Piedmont Amtrak service, which requires substantial Federal and State taxpayer subsidies, Greyhound ***pays*** taxes.

We submit that it is very questionable how much the proposed improved transit service to the Wake County Amtrak stations can be expected to increase this Amtrak ridership, particularly given that, in the scenarios that were set forth in the Plan, the "drive-to-station" scenario was the fastest by at least 30 to 40 minutes.

6. Vignette VI (Plan, p. 36) *Raleigh to Duke University*

Via regional express bus or commuter rail, connecting via various means.

It is difficult to reconcile the four specified transit scenarios in this vignette (which expand to six with the "walk or bike" option on two of them) to a single starting point in Raleigh:

1. Drive to park-and-ride, connect to regional express bus to Duke, or
2. Drive to park-and-ride, connect to commuter rail to Duke, or
3. Walk or bike to bus stop, connect to regional express bus to Duke, or
4. Walk or bike, connect to commuter rail to Duke, or
5. Drive.

The problem is that 3 and 4 above appear to be mutually exclusive with one and two, at least as far as the walk option in 3 and 4. If the traveler is close enough to walk to a commuter rail station, as specified in 4, then why would (s)he take a bus to cover the same distance? To attempt to make these comparisons more meaningful, we divided this vignette and restructured it, as follows:

VI.A:

1. Drive to park-and-ride, connect to regional express bus to Duke, or
2. Local Bus to regional express bus to Duke, or
3. Drive to park-and-ride, connect to commuter rail to Duke, or
4. Local Bus to regional express bus to Duke, or
5. Drive

[208] Amtrak, *Monthly Performance Report for May 2011*, (no title), page A-3.5.
[209] Greyhound web ticketing for one-week advanced ticketing. http://www.greyhound.com/
[210] Amtrak web ticketing for one-week advanced ticketing:
http://www.amtrak.com/servlet/ContentServer?pagename=Amtrak/HomePage

VI.B:

1. Walk or bike to bus stop, connect to regional express bus to Duke, or
2. Walk or bike, connect to commuter rail to Duke, or
3. Drive.

For VI.A., we will use as our trip origin the same location as in Vignette III., East Whitaker Mill Road at Pine Drive, approximately two miles North of downtown Raleigh. The transit traveler drives to either the park-and-ride at I-40/Hillsborough and catches the Downtown Raleigh to Downtown Durham express bus (page 92) or to the NCSU commuter rail station and catches the commuter rail line to Downtown Durham. From Downtown Durham, they use Durham Area Transit Authority (DATA) route 6 to the Duke campus and walk from the bus stop to the ultimate destination, the Duke University Chapel.

Table A8: Vignette VI.A Analysis Results

	Drive to Park-and-Ride at I-40/ Hillsborough, Regional Bus/DATA to Duke	**Drive to NCSU Commuter Rail Station to Durham, DATA to Duke**	**Drive**
Motorized Travel Time	59	56	33
Walk/Wait Time	17	17	5
Total Clock Time	**76**	**73**	**38**
Additional Perceived Time	26	26	8
Total Perceived time	**102**	**99**	**46**
Additional Delay Time	12	4	3
Total With Delay Time, Clock	89	77	45
Total With Delay Time, Perceived	114	103	52
Transit Extra Time, Clock	44	32	
Transit Extra Time, Perceived	62	51	
Transit Extra Clock Time, %	**97%**	**72%**	
Transit Extra Perceived Time, %	**118%**	**97%**	

The two transit alternatives are at, or close to, double the drive time without the delay factor. Commuter rail has a small (three minute) advantage over regional bus without delay, but the calculated eight-minute lower delay time (because commuter rail, not using roads, has no delay factor) gives it an overall twelve-minute advantage. (Again, we question the Plan's commuter rail travel speed and time assumptions.)

For the alternative sub-vignette, we will utilize the State Capital Building as our start point in downtown Raleigh, which is within 0.4 miles of More Square station, the departure point for the regional bus, and 0.6 miles of the proposed commuter rail station. From downtown Durham to the Duke University Chapel is the same as above, except that the bike scenarios have the traveler cycling for this last leg.

Table A9: Vignette VI.B Analysis Results

	Walk to bus stop, connect to regional express bus to Duke	Bike to bus stop, connect to regional express bus to Duke	Walk to rail station, connect to commuter rail to Duke	Walk to rail station, connect to commuter rail to Duke	Drive
Motorized Travel Time	65	55	50	40	32
Bicycle Time		14		15	
Walk/Wait Time	25	6	29	6	5
Total Clock Time	**90**	**75**	**79**	**61**	**37**
Additional Perceived Time	37	9	44	9	8
Total Perceived time	**127**	**84**	**123**	**70**	**45**
Additional Delay Time	14	12	11	8	7
Total With Delay Time, Clock	104	87	90	70	44
Total With Delay Time, Perceived	141	96	134	79	51
Transit Extra Time, Clock	60	43	46	26	
Transit Extra Time, Perceived	901	45	83	28	
Transit Extra Clock Time, %	**137%**	**96%**	**105%**	**60%**	
Transit Extra Perceived Time, %	**175%**	**87%**	**161%**	**54%**	

The walk alternatives are both over double the drive time, but the bike alternatives do significantly. However, even the most favorable comparison – bike to commuter rail – has, best case, transit over 50%, almost a half hour, longer than driving.

It is interesting to note that, even using the Plan's rail speed assumptions – which we question – commuter rail has an eleven minute advantage of express bus in this vignette, but cycling has a 15 to 18 minute advantage over walking. It is wise, and proper, for the Plan to make the fairly easy and relatively low-cost actions to ensure that cyclists can use the transit system without major issues, but it is quite another to prepare a transit plan that is based on a large percentage of riders accessing transit via cycling, particularly when the seasonable hot/humid and cold weather, and rain and snow, that are part of the Wake County experience, are factored in.

7. Vignette VII (Plan, p. 36) *Central Raleigh to Raleigh-Durham Int'l Airport (RDU Via regional bus, accessed in various ways*.

Because of the multiple scenarios in this vignette, we had to choose an origin point that, while meeting all of the criteria, is somewhat illogical for some. In this context, "Central Raleigh" had to refer to the central business district, as one of the options was to walk to the regional bus. We chose the North Carolina State Capital, which is approximately 0.4 miles from Moore Transit Center, a reasonable walk, but a rather short bicycle trip (one presumes that the traveler is taking his/her bicycle to the airport because (s)he is flying with it to his/her destination). Although there is a new bus service specified in the Plan (Downtown Raleigh/NC State to RDU, page 58), the only obvious difference between this route and the existing TT Route 100 is that the headway is reduced from 30 minutes to 15. The end-to-end travel time is reduced from the current 50 minutes to 45 minutes, evidently through changes that we could not identify, such as elimination of some stops on the existing line or, perhaps road improvements. Regardless, we assumed that the proportional time savings – $5/50^{th}$, or 10% – would apply, so we took three minutes of bus travel time off the first three scenarios and two minutes off the fourth. We utilized CAT line 6 for the short trip from the Capital Building to Moore.

Table A10: Vignette VII Analysis Results

	Walk to Bus Stop, Connect to Regional Bus to RDU	Bike to Bus Stop, Connect to Regional Bus to RDU	Take Local Bus, Connect to Regional Bus to RDU	Drive to Park & Ride, Connection to Regional Bus to RDU	Drive
Motorized Travel Time	27	27	30	23	18
Bicycle Time		4			
Walk/Wait Time	13	5	7	6	3
Total Clock Time	**40**	**36**	**37**	**29**	**21**
Additional Perceived Time	19	8	11	9	5
Total Perceived time	**58**	**43**	**48**	**38**	**26**
Additional Delay Time	6	6	6	5	4
Total With Delay Time, Clock	45	41	43	34	25
Total With Delay Time, Perceived	64	49	54	43	29
Transit Extra Time, Clock	20	17	19	9	
Transit Extra Time, Perceived	35	20	25	14	
Transit Extra Clock Time, %	**82%**	**67%**	**75%**	**37%**	
Transit Extra Perceived Time, %	**119%**	**67%**	**84%**	**46%**	

The fastest transit scenario was, as usual, the drive to park-and-ride, which only took approximately 50% more time than driving. The other scenarios took from 80% to 131% longer.

As in the first vignette, this one raises an important question re park-and-ride lots. There are two complimentary generalities regarding them:

1. "Transit" park-and-ride lots are intended for daily use and, therefore, are generally planned, posted, and enforced to prevent, or at least limit, overnight parking. If this is not done, then overnight parkers reduce the number of spaces available for daily commuters.
2. Airports generally rely heavily on their on-site parking lots for both accessibility to the airports and for the revenue from parkers to pay the costs of construction and operation of their parking facilities and, in some cases, other costs of airport operations. Generally, even off-site airport parking facilities that are no organizationally connected with the airport proper pay access fees in order to pick-up and drop off their clients at the airports. As such, airports generally do not favor transit access with "free" long-term parking. In fact, there is even something of a history of certain airports not being particularly enthusiastic about transit access because of the potential loss of parking revenues.

Therefore, the provision of a park-and-ride lot, or lots, that provide access to an airport should be done with care, including prior coordination with the airport to resolve any potential issues prior to commitment to proceed with the park-and-ride lot transit plan, and, most likely, the establishment of a no overnight parking policy (which would likely be far broader than airport parking) and publication and enforcement of same.