Light Rail

LIGHT RAIL: THE EXPERIENCE OF OTHER CITIES AND IMPLICATIONS FOR HAMPTON ROADS

With Modest Expectations, _____ Opens Rail Line After Years of Delays
– www.thetransportpolitic.com, March 22, 2010

Which American city best fits into the blank above? Charlotte, Seattle, or perhaps Denver? Norfolk in 2011? All of those are possibilities, but the actual city in question is Austin, Texas. The headline is from a blog discussing urban transportation. Austin is the central city in a region that just this year passed Hampton Roads in population. It now has a light rail system that was much delayed and rather more expensive than planned. What can we learn from Austin's experience and, for that matter, the experiences of other cities?

Light Rail Facts and Background

In 2007, there were 33 operating light rail systems in the United States. These systems generally use electric cars and operate on dedicated tracks. They are capital-intensive and require large up-front investments. **Honesty requires us to report that construction delays and cost overruns are endemic. Economic geographer and urban planner Bent Flyvbjerg found that, on average, recent urban rail projects ended up running about 40 percent over budget (Journal of the American Planning Association, summer 2002).**

Nevertheless, the share of light rail in U.S. transit ridership has been rising over time. In 2007, light rail trips represented 4.1 percent of total trips, up from 3.2 percent in 1995. Further, total public transit usage in general is on the rise. Approximately 5 percent of all workers commute daily via some sort of public transportation. This share was last reached in 1956. The primary reason we use mass transit is to go to work. Approximately 60 percent of all transit trips are for going to and from work. More than 30 percent of these commuters use transit five days a week.

Speed is an important consideration in commuting decisions. For relatively short trips (less than 10 miles), passengers on light rail trains travel about 15 miles per hour, while heavy rail trains travel about 20 miles per hour. (An example of heavy rail is the Washington, D.C., region's Metro system). These speeds often do not represent an improvement over automobile transportation times.

Light rail is usually more cost-effective than all other mass transit modes in terms of operating expenses. The primary reason for this is that with the exception of a few diesel versions, light rail trains are powered by electricity. Table 1 reports 2003 operating costs per passenger mile for urban transportation systems that operate both light rail systems and bus systems. The data support the following generalizations:

- The bus systems in these locations account for four times as many passenger miles as the light rail systems.

TABLE 1 OPERATING EXPENSES PER PASSENGER MILE: LIGHT RAIL VERSUS BUS, 2003							
Location	**Light Rail Annual Passenger Miles (Millions)**	**Light Rail Annual Operating Expenses (Millions)**	**Light Rail Operating Costs Per Passenger Mile**	**Bus Annual Passenger Miles (Millions)**	**Bus Annual Operating Expenses (Millions)**	**Bus Operating Costs Per Passenger Mile**	**Annual Light Rail Operating Savings (Millions)**
Baltimore	48.554	$34.502	$0.71	333.545	$209.831	$0.63	-$3.96
Buffalo	14.444	$17.046	$1.18	73.395	$78.754	$1.07	-$1.55
Dallas	120.674	$57.543	$0.48	248.024	$202.334	$0.82	$40.90
Denver	45.495	$20.068	$0.44	325.031	$217.440	$0.67	$10.37
Hudson-Bergen	25.885	$48.483	$1.87	921.989	$550.537	$0.60	-$33.03
Los Angeles	225.712	$86.200	$0.38	1440.547	$744.313	$0.52	$30.42
Portland	169.572	$55.296	$0.33	237.345	$171.402	$0.72	$67.16
Sacramento	47.465	$30.375	$0.64	75.326	$68.385	$0.91	$12.63
Salt Lake City	55.206	$19.926	$0.36	91.173	$83.820	$0.92	$30.83
San Diego	159.356	$38.986	$0.24	121.935	$66.839	$0.55	$48.37
Santa Clara-San Jose	26.815	$50.943	$1.90	153.531	$213.693	$1.39	-$13.62
St. Louis	124.973	$36.707	$0.29	122.166	$107.046	$0.88	$72.80
Averages	88.679	$41.340	$0.74	345.334	$226.200	$0.81	$21.78

Source: Sudhakar Raju, Journal of Public Transportation (April 2008)

- Both light rail and bus operating costs per passenger mile are highly variable, but the light rail average cost per passenger mile is about 10 percent lower than that for buses. More recent evidence, however, from the 2006 National Transit Profile indicates that this gap has widened to about 30 percent, or approximately 20 cents per mile. Few would contest the conclusion that light rail systems can be operated at a lower per passenger cost than "bus only" systems.
- In eight of the 12 cities/regions, the light rail systems save money by being more efficient than the accompanying bus systems.

Light Rail in Norfolk

Were one to ask Norfolk's older residents about light rail and The Tide, they likely would note that light rail really is not new to the city. Electric trolley cars provided public transportation from the late 19th century until the late 1940s. In fact, more than 100 years ago, light rail provided one of the first true examples of regional cooperation in Hampton Roads. Peggy Haile McPhillips, Norfolk city historian with the Norfolk Public Library, talks about a horse-drawn trolley transit system that started in 1870 and traveled along Church Street (http://www.npl.lib.va.us/history/history6.html). Notably, if the horses were sick, human beings would pull the trolley!

In 1894, electric trolley cars appeared and connected areas in Portsmouth and South Norfolk to downtown Norfolk. However, by 1925, buses began to replace the electric trolley system and by 1948, the electric system had disappeared.

According to its website, Norfolk's light rail system, The Tide, *"will extend 7.4 miles on an east to west alignment from the Eastern Virginia Medical Center through downtown Norfolk, continuing along the Norfolk Southern right-of-way, adjacent to I-264, to Newtown Road. Eleven stations will be constructed along the route with four park and ride locations that provide access to major areas such as Norfolk State University, Tidewater Community College (Norfolk Campus), Harbor Park, City Hall, MacArthur Center, and the Sentara Norfolk General Hospital."*

The Tide is under construction and is scheduled to open in 2011. It will run almost parallel to Virginia Beach Boulevard from the Newtown Road area to downtown Norfolk. Then, via several links, it will move west and terminate at the Sentara Norfolk General/Eastern Virginia Medical School medical complex. Along its Virginia Beach Boulevard path, The Tide will follow what is currently the HRT's (Hampton Roads Transit's) Bus Route 20, which begins at the oceanfront in Virginia Beach and heads west. Route 20 is one of HRT's most productive routes and more people ride it than any other HRT route. In January 2010, approximately 84,000 passengers used Route 20. Average weekday ridership is approximately 4,000 passengers, according to a memo from Phillip Shucet, president and CEO of the Transportation District Commission of Hampton Roads, on Feb. 18, 2010.

Data from the Virginia Department of Rail and Public Transportation's 2009 Comprehensive Operations Analysis indicate that Route 20 serves an average of 29 passengers per revenue hour, or about one-third more than the system average of 22 passengers per hour. The Fare Box Recovery Ratio (fare revenue divided by operating costs) for Route 20 is about 24 percent as compared to a system-wide average of only 17.3 percent. This means that the subsidy supporting Route 20 is approximately 76 percent of its operating costs, or about $1.90 per passenger. By comparison, on its typical bus line, the HRT system subsidizes 83 percent of the operating costs, which equates to $3.18 per passenger.

Hampton Roads Transit (HRT) provides public transportation within seven cities in Hampton Roads: Chesapeake, Hampton, Newport News, Norfolk, Portsmouth, Suffolk and Virginia Beach. It was formed in 1999 after a merger between Pentran (Peninsula) and TRT (Southside). HRT funding comes from the following sources:

- Federal Funding: 32%
- Local Funding: 31%
- Passenger Revenue: 21%
- State Revenue: 16%

Such subsidies are not unusual. For example, fare revenue covers only 28.2 percent of operating costs in St. Louis, 19.4 percent in Baltimore and 21.4 percent in Buffalo (Molly D. Castelazo and Thomas A. Garrett, "Light Rail: Boon or Boondoggle?" The Regional Economist, July 2004). Nationally, annual light rail system operating costs vastly exceed light rail revenues. The same is true for bus systems. Taxpayers fill in the balance. The result is a redistribution of income from taxpayers to those who choose to ride light rail.

Should HRT decide to close the portion of Bus Route 20 from Newtown Road to downtown Norfolk, it will force former bus passengers to travel via light rail to and from the city. HRT is aware of this. Table 3 in the publication "Comprehensive Operations Analysis for Hampton Roads Transit," produced by the Virginia Department of Rail and Public Transportation, discusses "Recommended Services Changes" for our region. One of the recommendations is that HRT "Implement bus preemption along Virginia Beach Blvd. Connect route with Newington Station when LRT complete."

The views of the Commonwealth's Department of Rail and Public Transportation do not determine official policy for HRT. Nevertheless, its recommendation with respect to closing portions of Route 20 recognizes the possibility of "channel conflict" – when the expansion of one arm of a business cannibalizes another arm. The department would wade in and deal with this problem by wiping out the competitive bus line. It is not clear what HRT will do; however, it appears that such action may be necessary if The Tide is to reduce congestion, lower energy consumption and diminish carbon emissions. HRT cannot reach those goals for The Tide if it runs competitive light rail and bus lines simultaneously over closely aligned routes.

Comparing Norfolk to Other Light Rail Cities

It is difficult to evaluate The Tide without reference to light rail systems that exist in other cities. We can see in column 3 of Table 2 that half of the light rail systems in comparable cities have only one line and that all of these one-line systems are relatively new. In general, the longer a system has existed, the greater the number of lines and the larger the number of riders. The very new Seattle and Charlotte light rail systems do not yet have large riderships. To some observers, the ridership numbers in column 2 provide evidence in favor of the "If you build it, they will come" hypothesis.

TABLE 2

COMPARING CITY LIGHT RAIL SYSTEMS

City/Region	Ridership	Lines	Stations	Year Opened	Length In Miles
Baltimore	34,700	3	33	1992	30
Charlotte	20,000	1	15	2007	9.6
Dallas	70,000	3	38	1996	48.6
Denver	70,400	5	36	1994	39.4
Houston	45,000	1	16	2004	7.5
Minneapolis-St. Paul	32,500	1	19	2004	12.3
Phoenix	43,509	1	32	2008	20
Pittsburgh		4	66	1987	25
Portland	107,600	4	84	1986	53
Sacramento	110,600	2	45	1987	37.4
Salt Lake City	53,100	3	28	1999	19
Seattle	16,120	1	13	2009	15.6
Norfolk		1	11	2011	7.4

Sources: "Light Rail Transit," Encyclopædia Britannica, 2010; Encyclopædia Britannica Online, May 5, 2010, http://www.britannica.com/EBchecked/topic/340676/light-rail-transit; www.wikipedia.com; city Internet websites

Of the light rail systems described in Table 2, Charlotte's appears to be closest to The Tide. The Charlotte light rail system (the Lynx) has one line, approximately the same number of stops as is contemplated for The Tide, and is about the same length. Early returns on the Lynx are mixed. Ridership is greater than expected, but these passengers appear to have been taken from existing bus

routes. Thus, it is not clear that congestion has been improved due to this channel conflict.

In addition, transportation planners in Charlotte recently have struggled with lower than expected sales tax revenue. This has forced them to reconsider a planned connection of a streetcar line to the Lynx. Further, like most central cities, Charlotte is interested in getting financial buy-in from its suburbs, but this has been largely unsuccessful because suburbanites view the Lynx as primarily benefiting central city residents.

Table 3 presents additional data for other cities/regions that have light rail systems. The focus of this table is the ranking of light rail and bus use relative to city and regional population rankings. Both the light rail and the bus rankings are for metropolitan regions. The rankings are by number of unlinked passenger trips.

By comparing the population rankings to the usage rankings, we can obtain a rough idea of what Norfolk might expect with respect to transit usage. Dallas, for example, is the eighth-largest city in the country and is located within the fourth-largest metropolitan area. Nevertheless, in terms of total miles traveled, Dallas ranks 10th in light rail trips, but only 23rd in bus trips. Dallas, then, is an "auto city" that does not rely heavily on public transportation. Phoenix, which does have a light rail system, also follows in this vein and its residents favor automobiles over public transportation.

In Baltimore, however, citizens use both bus and light rail relatively more than one might expect. The same is true for the citizens of Salt Lake City.

The number of bus trips in Hampton Roads is lower than expected for a region of 1.6 million people, but the miles traveled on buses are about what is expected. Our bus riders take longer trips.

Of course, we do not know what light rail ridership in Norfolk will be, but if the annual ridership of 4.5 million forecast by HRT turns out to be accurate, then The Tide will rank between the 18th and the 19th most traveled light rail systems in terms of passenger trips. This would place us between Buffalo and Cleveland.

Light rail Lynx train in station.
Charlotte, N.C.

The Tide website cites these benefits of light rail:

Reduces Traffic Congestion: Light rail can move as many people as four to six lanes of interstate highway.

Positive Economic Impact: A report commissioned by the Federal Transit Administration to understand the economic impact of public transportation found that there was a significant positive economic impact on jobs and business revenues. The study found that in the year following the transit investment, 314 jobs are created for each $10 million invested in transit capital funding. In addition, transit operations spending provides for a direct infusion to the local economy with more than 570 jobs created for each $10 million invested in the short term.

Business Attractor: Almost half of the nation's Fortune 500 companies, representing over $2 trillion in annual revenues, are headquartered in America's transit-intensive metropolitan areas.

Business Sales Gains: Businesses would realize a gain in sales of three times the public sector investment in transit capital - a $10 million investment results in a $30 million gain in sales. Regarding transit operations spending, businesses would see a $32 million increase in business sales for each $10 million in transit operations spending.

Economic Development Generator: Rail lines are fixed, high-value assets. Developers are more comfortable investing capital into a system that will continue. Since 1977, when the first Metrorail station opened in Virginia, Metrorail has generated substantial economic benefits for the Commonwealth. By 2010, Metrorail will generate: $2.1 billion in additional Commonwealth revenues and net revenues of $1.2 billion (in excess of the Commonwealth contributions to Metrorail). Every taxpayer dollar invested in public transportation generates about $4 to $9 in economic returns, according to the American Public Transportation Association.

Cheaper than Roadways: New urban highways cost as much as $100 million per mile, whereas the Norfolk light rail line costs about $45.6 million a mile.

Saves You Money on Gas: Public transportation saves more than 855 million gallons of gasoline, or 45 million barrels of oil, a year – enough to heat and cool one-fourth of American homes annually, according to the Center of Transportation Excellence.

Better for the Environment: Public transportation generates, per passenger mile, 95 percent less carbon monoxide and 92 percent less volatile organic compounds than passenger vehicles – and about half as much carbon dioxide and nitrogen oxide.

Traffic Congestion Costs Money, Transit Saves Money: Without transit, the nation's $40 billion in annual traffic congestion losses would be $15 billion higher. In fact, if all the Americans who take transit to work decided to drive, their cars would circle the Earth with a line of traffic 23,000 miles long. Americans lose more than 1.6 million hours a day stuck in traffic.

Transit Increases Family Spending Budget: Transportation accounts for approximately 17 percent of our Gross Domestic Product, which means transportation is critical to business and personal economic security. For American families, transportation represents 18 percent of household spending, the second largest expenditure after housing. Americans living in transit intensive metropolitan areas save $22 billion per year in transportation related expenses. The annual cost of driving a single-occupant vehicle is $4,800 to $9,700, depending on mileage. The annual average cost for public transportation for one adult is $200 to $2,000, depending on services used, according to the Center for Transportation Excellence.

Increases Property Value: Properties located within a quarter-mile radius of a light rail station increase in value by up to 25 percent more than other properties, according to studies conducted by the Urban Land Institute. There are some exceptions, the studies show, such as properties next to Park and Ride lots.

TABLE 3 ADDITIONAL COMPARISONS OF LIGHT RAIL SYSTEMS						
City Or Region	Metropolitan Population Rankings, U.S.		Top 50 Light Rail Rankings, U.S.		Top 50 Bus Rankings, U.S.	
	Region	City	Trips	Miles	Trips	Miles
Baltimore	20	20	17	15	13	11
Charlotte	33	18	NA	NA	46	47
Dallas	4	8	10	5	23	17
Denver	21	24	9	7	14	10
Houston	6	4	13	17	11	5
Minneapolis-St. Paul	16	47	15	14	18	13
Phoenix	12	5	NA	NA	24	28
Pittsburgh	22	60	16	16	22	15
Portland	23	29	NA	NA	20	20
Sacramento	25	37	50	≥ 51	12	11
Salt Lake City	48	126	11	10	42	32
Seattle	15	25	22	22	19	7
Hampton Roads	36	80	NA	NA	48	43

Source: 2009 Public Transportation Fact Book, 60th Edition, April 2009, American Public Transportation Association

Table 4 supplies data from the American Community Survey on how people travel to work. Column 2 notes the percentage of a region's workers who do not have an automobile available to them. One can see that automobiles are less likely to be owned in Baltimore and Pittsburgh in the East and Portland and Seattle in the West. We suspect that this is for different reasons. Baltimore and Pittsburgh have large numbers of lower-income households, while Seattle and Portland claim relatively more people who choose not to have cars because of their support for environmental causes. Both factors tend to increase citizen support for large public transit systems, which all four regions boast.

TABLE 4 TRAVEL TO WORK CHARACTERISTICS					
City/Region	Percent No Vehicle Available	Percent Drive Alone	Percent Carpool	Percent Public Transportation	Mean Travel Time
Baltimore	5.1	75.96	9.75	6.43	29.2
Charlotte	2.6	79.49	11.65	1.95	25.1
Dallas	2.2	79.94	11.50	1.64	26.8
Denver	3.0	75.29	10.05	4.72	26.7
Houston	2.9	78.12	12.57	2.65	28.5
Minneapolis-St. Paul	2.7	78.48	8.71	4.33	24.1
Phoenix	2.9	74.96	13.70	2.40	26.5
Pittsburgh	3.9	77.17	9.35	5.72	25.2
Portland	3.5	71.57	10.74	6.10	24.9
Sacramento	2.1	75.14	12.28	2.66	25.8
Salt Lake City	2.1	75.35	12.70	3.46	22.1
Seattle	3.1	70.03	11.72	7.82	27.9
Hampton Roads	2.7	80.36	9.94	1.80	23.4

Source: 2006-2008 American Community Survey 3-Year Estimates, U.S. Census Bureau, http://factfinder.census.gov/

By contrast, Hampton Roads is an area where a large majority of people drive to work; only 2.7 percent of households don't have access to an automobile and column 4 reveals that more than 80 percent of all workers drive alone to their workplace. This could mean that light rail will be a tough sell in Norfolk. However, it also means there is greater than usual potential for The Tide to garner riders. "Ride The Tide" eventually could turn out to be a popular alternative to solo drives to work.

Column 6 of Table 4 tells us that relative to the regions that have light rail, commuters in Hampton Roads do not spend as much time traveling as the others – the single exception being the Salt Lake City metropolitan area – though the

variance from highest to lowest is only about seven minutes. Interestingly, there is no correlation in this sample of regions between commuting time and the percentage of drivers that use public transportation. One might have expected to see long commute times stimulate use of public transportation. Not so.

Finally, it is striking how similar the Hampton Roads region is to Charlotte in terms of how workers choose to get to work. The drivers in both regions turn their noses up at public transportation as a means to get to their jobs and are less likely to carpool.

The Cost of The Tide

Virtually every light rail system constructed in the United States has been afflicted with cost overruns. The Tide has been no different. The Tide's website informs us:

- "The Tide has experienced two significant public episodes of cost overruns. The first, reported in the fall of 2008, made it clear that the original projected cost of the project – $232 million – was low. Unfortunately, the assessment that produced the new cost – $288 million – lacked the rigor necessary to determine a reliable estimate.
- "In August and September of 2009, an internal HRT assessment looked at a more reasonable cost-to-complete. This work was compiled in an October 2009 report, and put the project cost at $324 million. The October 2009 report was not made public. The report's author suggested that her work be reviewed by an independent entity. The October 2009 HRT assessment served as the foundation for the AECOM report issued on January 27, 2010. AECOM's estimate of a cost-to-complete was $335 million based on the limited time and material they had on hand to review."

While the ultimate construction cost of The Tide will not be known until it is completed, if the AECOM Technology Corp. assessment is on target, then the cost overrun will be 51 percent, or $103 million. This does not qualify as pocket change, but as we will see, the high level of subsidy provided by the U.S. government for the construction of The Tide dramatically reduces the financial obligation of Norfolk.

Benefits and Costs: What Does Experience Tell Us?

Todd Litman of the Victoria Transport Policy Institute (Canada) has been an influential evaluator of light rail systems. He concludes that high-quality public transportation systems require $268 in additional annual subsidies per capita and $104 in additional annual fares paid by riders per capita. However, he estimates the annual per capita benefits to be at least $1,040. Note that Litman's analysis compares ordinary public transportation systems to those that are of "high quality." This is not necessarily the same as light rail, though most light rail systems are included in the "high quality" category. (Litman's work is found in "Raise My Taxes, Please! Evaluating Household Savings from High Quality Public Transit Service," Victoria Transport Policy Institute, 2010).

Another of Litman's papers, "Rail Transit in America: A Comprehensive Evaluation of Benefits" (Victoria Transportation Policy Institute, 2009), discusses light rail systems similar to The Tide. The most often cited benefit of light rail systems is reduced traffic congestion. Litman cites research indicating that congestion is reduced as rail transit mileage increases, but increases as bus transit mileage rises. Thus, he concludes that rail systems often are efficient substitutes for bus systems.

Litman also reports research that the savings realized because of reduced congestion exceed the subsidies required for rail construction. He further notes, however, that the savings are greatest for large rail systems. Even so, for small rail systems similar to The Tide, he concludes that congestion cost savings are larger than for "bus only" systems.

Litman's research suggests small rail systems yield about $40 in annual congestion-reducing benefits per capita compared to bus-only systems. If we consider only the residents of Norfolk in this equation, then Litman predicts the annual benefit from the reduction in

congestion in Norfolk will be approximately 234,220 x $40 = $9,368,800. These savings are primarily a product of reduced travel times, which presumably are valued at the prevailing hourly wage rate of commuters.

There also could be computable financial benefits associated with reduced energy usage, diminished pollutants and carbon emissions, increased economic activity, diminished fatal automobile accidents, etc. As we will soon see, however, the reductions in energy consumption, pollutants and carbon emissions are largely illusory. Indeed, a case can be made that automobiles are more energy efficient and environmentally friendly than light rail systems.

The $9.37 million estimate of annual congestion savings in Norfolk is more than sufficient to catch one's attention, although it would take almost 36 years of such savings to pay for the estimated $335 million construction cost of The Tide. Further, this is without discounting the savings to reflect the fact that the $335 million could have been used for other purposes. If we discount these future congestion benefits at 5 percent (a conservative assumption), and assume that the congestion savings grow at 2.5 percent per year, then it would take 76 years (the year 2087) for the congestion savings to pay for the construction costs. Unfortunately, the tracks now being constructed will have worn out long before 2087.

Hence, taken by itself, and setting aside other benefits and costs, Norfolk's initiative would not be regarded in conventional financial circles as an attractive investment relative to alternatives. Nevertheless, as one astute observer put it to us, "If you're playing with someone else's money, that really does change everything." As we will see in a section below, approximately half of the cost of The Tide will be paid for by non-Norfolkians, primarily taxpayers from other states. This makes a tremendous difference, at least from the standpoint of the taxpayers of the city of Norfolk.

Since reduction in congestion is one of the chief benefits delivered by light rail, let's focus on driving congestion in Norfolk compared to other regions. The Texas Transportation Institute reports congestion data for the Hampton Roads region rather than for Norfolk. Column 2 of Table 5 reports the percentage of peak period travel in each region that is considered to be congested – that is, afflicted by extensive driving delays. The higher the congestion percentage in column 2, the more likely it is that light rail would deliver congestion-reducing benefits.

TABLE 5

REGIONAL CONGESTION DATA

	Congested Travel		Congestion Costs	
City/Region	**Percent of Peak**	**Delays Per Peak Traveler**	**Dollar Costs Per Peak Traveler**	**Rank**
Baltimore	69	44	$982	13
Charlotte	60	40	$876	23
Dallas	66	53	$1,077	9
Denver	67	45	$913	21
Houston	73	56	$1,112	5
Minneapolis-St. Paul	58	39	$812	26
Phoenix	68	44	$1,034	11
Pittsburgh	24	15	$300	72
Portland	68	37	$765	34
Sacramento	76	39	$805	28
Salt Lake City	54	27	$535	48
Seattle	66	43	$938	17
Hampton Roads	51	29	$579	42

Source: Texas Transportation Institute, http://mobility.tamu.edu/ums/

For Hampton Roads, the data indicate that during peak times our major roadways are congested 51 percent of the time. Only Pittsburgh has a lower value in this regard. Houston and Sacramento suffer from the most congestion. Though not reported in Table 5, Los Angeles (86 percent) and Chicago (79 percent) have the greatest peak travel time congestion in the United States.

Column 3 of Table 5 reports driver delays per peak travel trip, measured in hours for 2007. Only Pittsburgh and Salt Lake City have lower total delay hours than

Hampton Roads. Charlotte's number of hours delayed is 30 percent higher than that of Hampton Roads.

Column 4 supplies the Texas Transportation Institute's estimate of the average annual dollar value of congestion cost per traveler. This estimate reflects the average wages rate of commuters in each region and presumes that time wasted sitting in traffic jams is worth money. This number translates to the annual average congestion cost per peak traveler. Once again, only Pittsburgh and Salt Lake City had lower congestion costs than Hampton Roads.

Column 5 ranks Hampton Roads relative to other regions with respect to its congestion costs per traveler. Only the 100 largest regions are considered. The higher the number, the lower the congestion costs. Hampton Roads' ranking (42nd) indicates that the cost of traffic congestion here is less than in Charlotte (23rd), a region with which we are often compared, but higher than Salt Lake City (48th) and Pittsburgh (72nd).

A second benefit associated with light rail systems is a probable reduction in costs associated with road maintenance (fixing potholes and the like), while a third benefit is savings associated with commuters not having to pay for parking. To the extent that an individual can utilize light rail to avoid owning an automobile at all, there could be a fourth class of benefits. This, however, would appear to apply more to metropolitan areas such as New York City rather than to Norfolk.

A fifth possible benefit associated with light rail systems is that they may enable citizens to spend a smaller share of their incomes on transportation, thus increasing their disposable incomes and allowing them to spend more money on other things. In this regard, there is some evidence that lower-income residents often benefit the most from the introduction of mass transit systems. It's not clear this would be true in Norfolk given the path of The Tide; however, it is a topic worthy of further investigation once the system is in operation.

Data from other cities and regions indicate that total consumer spending on "small rail" transportation actually is about $150 per person, per year, higher than is true for "bus only" systems. This translates to 15.8 percent of one's expenditures, versus only 14.9 percent for bus-only regions. The major expenditure gains from mass transit systems appear to accrue to large rail systems (for example, the New York City subway system). Citizens in New York City spend about $500 less annually for transportation than they would in the absence of the subway system.

A sixth benefit associated with light rail relates to a reduction in traffic deaths, which are lower in small-rail cities than in bus-only cities. **Specifically, cities with small-rail systems have 9.9 traffic-related deaths per 100,000 citizens annually, compared to 11.7 for bus-only cities.** How much is this worth? The U.S. government conventionally places a value of about $3 million on a life when it makes decisions concerning transportation, health and safety expenditures. This means that a small-rail system would save a predicted 1.8 x 2.3422 = 4.22 lives annually.[1] These 4.22 lives are worth 4.22 x $3 million = $12.66 million annually, which is about one-quarter larger than the predicted congestion-reducing benefits of light rail.

We assure the squeamish reader that placing financial values on life is a conventional decision technique used by federal agencies. We also wish to note that the "saved lives" benefit easily is the largest documentable benefit associated with the introduction of The Tide.

A seventh argued benefit of light rail systems relates to a reduction in energy usage and pollution emissions. The data in Table 6 allow us to shed a bit of light on the degree to which light rail diminishes energy use and pollution in the regions we have been considering. Columns 2 and 4 report, respectively, the total energy usage of a transportation system measured in British Thermal Units (BTUs) and the carbon dioxide (CO_2) emitted by that system. Columns 3 and 5 measure the same variables, but do so for light rail systems specifically. Each of the numbers in columns 2 through 5 is per passenger mile.

Randal O'Toole, author of "Gridlock: Why We're Stuck in Traffic and What to Do About It" (Cato Institute, 2009), notes that in the United States, the average BTUs of energy consumption per passenger mile (about 3,700) is just about the same for passenger cars and light rail. Other studies have estimated the BTU energy consumption of automobiles per mile to be in the range of

[1] 1.8 = 11.7 – 9.9, and is the additional number of lives per 100,000 citizens saved annually by small rail.

4,400 (David S. Lawyer, "Does Mass Transit Save Energy?" http://www.lafn.org/~dave/trans/energy/does_mt_saveE.html).

If we accept 3,700 to 4,400 BTUs per passenger mile as the appropriate range for automobile travel, then the data in Table 6 reveal that bus-only transit systems and light rail systems often are less energy efficient than automobiles. Further, as automobiles become more fuel efficient (the "fleet average" miles per gallon of automobiles produced by U.S. manufacturers will rise from about 25 mpg today to more than 35 mpg in 2016, a 40 percent improvement), automobiles will in most cases be more energy efficient per passenger mile than either bus-only or light rail transit systems.

The story is a bit different when we examine carbon emissions. Passenger cars on average emit 50 percent more pounds of carbon dioxide per passenger mile than light rail. It is not clear if the enhanced mpg standards will alter this relationship.

Whatever conclusion we might seek to reach about the energy consumption of a light rail system such as The Tide becomes more complicated if we take into account the energy source of the electricity used to power the system. Electricity generated by coal will in general create more carbon dioxide than electricity generated by solar/wind/nuclear means. Hence, regions will differ with regard to how much light rail will improve pollution. Some of the energy impact of The Tide therefore depends upon how Dominion Virginia Power chooses to generate its electricity. This is not something HRT can control.

The data in Table 6 indicate that in Baltimore, Denver and Pittsburgh, light rail actually increases energy consumption and worsens pollution. Hence, it is not as efficient as the other modes of public transit. Indeed, if the average passenger automobile utilizes about 3,700 BTUs per passenger mile, then only four of the 12 transit systems in our sample are more energy efficient than this. **If the higher-end automobile BTU estimate per passenger mile of 4,400 is used, then six of the 12 transit systems are more energy efficient than automobiles, but only four of nine light rail systems meet the same standard.**

While we have no direct way to do so, we also should take into account the energy and environmental costs connected to the construction of a light rail system. Both appear to be large, but no reliable data are available that measure these costs. We should add that the congestion costs (increases, not reductions) associated with The Tide construction have been legendarily large in size.

The light rail city located closest to Hampton Roads for which we have data is Baltimore. The energy use and pollution numbers for light rail in Baltimore are discouraging because they are much higher than for the bus portions of its public transportation system and actually are noticeably inferior to ordinary automobile transportation. Baltimore's light rail system may appear to be green, but it is not. However, Baltimore operates one of the nation's older light rail systems and no doubt the technology being adopted by the HRT will involve more adept, fuel-efficient, clean vehicles. Even so, it is worth noting that in the early 1960s, many mass transit authorities argued that buses were cheaper to operate and more flexible than streetcar systems. In Baltimore, at least, it appears they are correct.

It would be hazardous to make too much of the energy and pollution data reported in Table 6. In the language of economists, *ceteris paribus* (other things held constant) may well have been violated. That is, there are many other relevant variables not considered in Table 6 that may well account for the differences we observe. For example, it seems likely that topography and atmospheric conditions in these regions and the sources of the energy they utilize for mass transit make a difference. What we may be observing in Table 6, then, is not the relative inefficiency of mass transit or light rail systems, but the influence of other factors not included in the data.

Nevertheless, the data in Table 6 should stimulate a degree of caution among those who boldly proclaim that mass transit systems in general, and light rail in particular, save energy and reduce pollution. The evidence is much more nuanced than many suppose.

An eighth and final benefit often cited by proponents of light rail is that the introduction of a light rail system increases property values along the system. This, they argue, is good not only for the private property owners involved, but also it generates higher property tax collections for local governments. Thus, the economic boost a light rail system provides to a city could pay for part of its construction cost.

TABLE 6 POLLUTION EMISSION AND MASS TRANSIT SYSTEMS, 2006				
	Urban Area Transit Energy Consumption, Per Passenger Mile		Carbon Dioxide Emissions, Per Passenger Mile	
Region	BTUs-Total Transit System	BTUs-Light Rail	CO_2-Total Transit System	CO_2-Light Rail
Baltimore	4,497	8,128	.67	1.09
Charlotte	4,488	NA	.72	NA
Dallas	5,414	4,466	.85	.60
Denver	3,596	4,400	.59	.78
Houston	3,528	2,849	.57	.39
Minneapolis-St. Paul	3,722	2,498	.56	.35
Phoenix	NA	NA	NA	NA
Pittsburgh	5,357	9,265	.82	1.18
Portland	3,008	2,482	.36	.08
Sacramento	5,613	4,821	.69	.29
Salt Lake City	3,241	2,830	.54	.56
Seattle	NA	NA	NA	NA
Norfolk	4,133		.66	

Sources: Randal O'Toole, "Gridlock: Why We're Stuck in Traffic and What to Do About It" (Cato Institute Press, 2009). Original data are from the 2006 National Transit Data Base, Federal Transit Administration.

In a 2007 article in the journal Urban Studies, Daniel Hess and Tangerine Almeida reviewed empirical research in this area. Most studies do find that light rail increases property values, but those increases typically are focused on the properties closest to the light rail stations. For example, **Hess and Almeida found in Buffalo, N.Y., that every foot a home was closer to a light rail station increased average property values between 99 cents and $2.31, or between $1,300 and $3,000 per home. These average effects, however, did not apply to all areas.**

Benefits are positive near stations in high-income areas, but negative near stations in low-income areas. Further, some properties literally can be too close to a station; noise, vibration, clutter and increased traffic apparently cause decreases in some property values. Nationally, this latter phenomenon appears to apply primarily to older rail systems.

It is difficult to predict exactly what will happen when The Tide begins operation. However, we expect some businesses to increase in value, particularly those in Norfolk's downtown area and some near Norfolk State University, if the now-vacant land near NSU's McDemmond Center for Applied Research is capably developed. In their article "Light Rail – Boon or Boondoggle?" Molly Castelazo and Thomas Garrett, economists at the St. Louis Federal Reserve Bank, argue that the costs of light rail are spread among almost all citizens, but that a specific individual's share of the cost is sufficiently low so that relatively few people are disadvantaged enough to complain. However, the benefits, they argue, are concentrated among a much more limited group of people. Property owners near a light rail line, engineering and architectural firms that work on light rail systems, workers who build the light rail and some elected officials tend to benefit from the introduction of a light rail system. They are intensely interested in the system and are willing to expend time, energy and funds to make it happen. This description may or may not apply to light rail development in Norfolk, but it constitutes a classic argument why incremental government activity occurs.

An oft-cited critic of light rail systems is James DeLong of the libertarian Reason Foundation. In his now somewhat dated "Myths of Light-Rail Transit" (Reason Public Policy Institute, Policy Study #244, September 1998), DeLong takes issue with many of the argued benefits advanced by supporters of light rail. For example, he contends that light rail actually is not really rapid transit because it takes travelers time to get to the station, engage in transfers and utilize linkages that may not be as convenient as buses. DeLong also notes that demand forecasts for light rail usually have exaggerated actual ridership. He believes this is true because many trips taken by individuals do not involve commuting and take place at off-peak times. He asserts that as much as 60 percent of afternoon travel has nothing to do with work (running errands, picking up children, etc.) and will not involve use of light rail. Further, such trips can be flexibly scheduled at off-peak times. DeLong references a study that found, of all the cities that

started light rail systems in the 1970s and 1980s, only San Diego experienced an increase in the share of commuters using public transportation between 1980 and 1990.

The Question of Who Pays

CONSTRUCTION

A rational person might conclude that the costs of constructing a light rail system exceed the benefits for Norfolk, but still be in favor of building and expanding the system if: (1) someone else is going to bear the cost; and (2) the light rail system is more efficient than the bus system it will at least partially replace. The Hampton Roads Planning District Commission (HRPDC) revealed that $167 million of the original $222 million cost (or 75 percent) of the Norfolk light rail was to be paid for by funds coming from outside the city. There are not many projects that any city can undertake in which three-fourths of the cost is transferred to citizens outside the city. Economists refer to such shifting of costs as "tax exporting."

The same HRPDC study indicated that HRT was planning over time to purchase $318 million worth of new buses, of which only $121 million, or 38 percent, would come from external sources. It is easy to see that it might well be wise for Norfolk to forge ahead with light rail and to eschew buses, given the different sizes of the subsidies for each. After all, the average cost to a citizen of Norfolk is approximately twice as high if bus transportation is expanded and improved compared to developing light rail.

Cost overruns for The Tide have diminished the relative size of the subsidy for light rail. However, even if The Tide turns out to cost $335 million (a pricey, but not surprising, $45 million per mile) and all of the cost overruns must be paid by the citizens of Norfolk, the $167 million in external funds still represents a 50 percent subsidy to Norfolk by taxpayers located around the nation. Hence, cost overruns or not, the proportional subsidy of outsiders for light rail in Norfolk exceeds the proportional subsidy for buses. And, if the city of Norfolk is able to convince the Commonwealth or the U.S. government to pay for some of the current cost overruns, then light rail becomes even more attractive to Norfolk taxpayers relative to expanding the HRT bus system.

We would be negligent if we did not take note of one particular class of people who have borne implicit costs associated with the construction of The Tide. These are the business owners who have suffered financial losses because of the construction, drivers who have experienced sometimes-unpredictable delays because of construction, and citizens who have had to come to terms with dusty air and dirty surfaces. We do not have a number to place upon these costs; we do know they are non-negligible.

Ultimately, despite the good fortune of Norfolk, taxpayers should bear in mind the case of the St. Louis MetroLink light rail system. **Two Federal Reserve economists (Castelazo and Garrett, cited above) found that annual taxpayer subsidies for light rail in St. Louis were so large that they "could instead be used to buy an environmentally friendly hybrid Toyota Prius every five years for each poor rider and even to pay annual maintenance costs of $6,000.** Increases in pollution would be minimal with the hybrid vehicle, and 7,700 new vehicles on the roadway would result in only a 0.5 percent increase in traffic congestion. And there would still be funds left over – about $49 million per year. These funds could be given to all other MetroLink riders (amounting to roughly $1,045 per person per year) and be used for cab fare, bus fare, etc."

It is fortuitous that Norfolk has "sugar daddies" (the Commonwealth and the U.S. government) that will pay approximately half of the costs of constructing The Tide, even after inclusion of the estimated 44 percent cost overrun. If the experience of Norfolk is similar to that of other cities with light rail, in financial terms, this will turn out to be a good investment for Norfolkians, assuming it can break even financially on the operation of The Tide. Norfolk will recoup its investment as soon as 2019 if its experience mirrors other light rail communities in terms of reductions in congestion and fewer

traffic fatalities. However, this assumes there will be no annual operational financial losses on The Tide.

As good as this result could be for Norfolkians, it does not mean that the construction of light rail in Norfolk is an intelligent investment for society as a whole, for taxpayers across the nation must pay the construction subsidies. It is difficult to mount a strong argument why taxpayers in, say, Gallup, N.M., or Bangor, Maine, should subsidize light rail travel in Norfolk.

OPERATIONAL COSTS

Accumulated evidence suggests not only that light rail in Norfolk will require significant annual operational subsidies, but also that it represents a redistribution of income from all taxpayers to those who choose to ride light rail. Every mile traveled, every passenger carried, likely will require a financial subsidy. HRT currently collects about 20 percent of its revenue from passenger fares. Let's do a bit of modeling to provide some basis for this conclusion.

Table 1 revealed that the cost per passenger mile in 12 light rail cities ranged between 29 cents (St. Louis) and $1.90 (Santa Clara-San Jose) in 2003. The average cost per passenger mile for light rail in the 12 cities was 74 cents. More recent data from the 2006 National Transit Data Base of the Federal Transit Administration found an average operating cost per passenger mile of 57 cents for light rail and 77 cents for buses. If we take the intermediate value of 67 cents per passenger mile and update it to 2011, then an estimate of 75 cents per passenger mile seems reasonable.

The Tide will be 7.4 miles in length. Let's assume that the average passenger rides four miles per trip. Then, the average operating cost of a round-trip ride to The Tide will be 4 x 2 x $.75 = $6. Can The Tide successfully charge $6 per trip and coax drivers out of their cars and riders out of their Route 20 buses? We believe this would be a stretch. The not-yet-open 27-mile Heartland Light Rail System in Kansas City, Mo., has bandied about a $4 round-trip fare, but that would generate only about 40 percent of projected operating costs in that system's first year. In our hypothetical example, a $4 round-trip fare for The Tide would generate only two-thirds of anticipated operating costs per fare mile.

In the absence of a thorough, well-grounded economic study of the demand for rides on The Tide at various price levels, it is difficult to predict precisely how large the annual operating losses will be. However, it would be nothing short of astonishing if The Tide were able to break even financially. In the usual situation nationally, fare collections from passengers seldom exceed one-third of operating costs.

Taxpayer subsidies for The Tide almost certainly are going to be required. The HRT will find itself between the proverbial rock and hard place here, however. A high subsidy will enable lower fares and attract more passengers, but will require taxpayers to make a larger contribution. A low subsidy, on the other hand, while reducing the burden on taxpayers, would increase fares and discourage ridership.

It seems inevitable that some combination of taxpayers is going to subsidize those who ride The Tide. This is hardly unprecedented; taxpayers already subsidize about three-quarters of the cost of transporting riders on HRT buses. Further, since light rail subsidies per passenger mile typically are lower than those for buses, it could well be the case that The Tide actually will reduce the existing redistributional burden on taxpayers.

Final Observations

Perhaps it really doesn't make much difference what previous empirical studies tell us about the performance and efficiency of light rail systems because The Tide is under construction and will begin operation in 2011. It is fair to say that evidence concerning the overall efficacy of light rail is mixed at best, but this evidence is not necessarily relevant to The Tide because of the $167 million subsidy the city of Norfolk is receiving for the project.

Nevertheless, it is worth noting what we have found:

- Reductions in congestion due to light rail often are small because the appearance of light rail does not always convince people to abandon automobiles and buses.

- If reduced congestion were the only benefit derived from The Tide, and the system costs $335 million, then it would be 2087 before the current value of this benefit would exceed the construction cost.

- **The lifesaving benefits from light rail typically are $12.66 million annually for a city the size of Norfolk and reflect the likelihood that there will be fewer fatal traffic accidents because of The Tide. These lifesaving benefits exceed the congestion-reducing benefits of light rail (which we estimate to be $9.37 million in 2011).**

- If one adds the lifesaving benefits to the congestion-reducing benefits of The Tide, then the sum of these annual benefits is $12.66 million + $9.37 million = $22.03 million. Thus, in 2030, the current value of these benefits will exceed construction costs for the citizens of the United States collectively. However, since Norfolk is paying only about half of those costs, it will recoup the value of its investment by 2019. This assumes a discount rate of 5 percent with respect to future benefits and ignores subsequent subsidies that could well be required to operate The Tide. That is, this particular projection assumes that The Tide can break even financially on its operations.

- Ridership sometimes has been disappointing when new light rail systems have opened, though ridership tends to grow over time. "If you build it, they will come" does appear to apply to some (though not all) light rail systems.

- **Ridership will grow much more rapidly if American gasoline prices rise toward the levels one sees in Western Europe. Oil priced at $150 per barrel might be bad news to most Americans, but it would be good news for The Tide.**

- Ridership will grow much more rapidly if the light rail system is expanded to cover major population concentrations and travel paths (for example, Naval Station Norfolk, Old Dominion University, the oceanfront and perhaps Norfolk International Airport, Regent University/CBN and Greenbrier). However, in the absence of major construction and operational subsidies, these additional sites may not be financially feasible. Hard analysis is required.

- **Nationally, light rail systems typically generate only one-quarter to one-third of their operation expenses from fares. Significant operation subsidies are required.** If The Tide imitates past experience, then some combination of taxpayers will be asked to foot this bill. This represents a subsidy from all taxpayers to those who choose to ride light rail. A wide range of different income classes typically shares these subsidies.

- **Mitigating the anticipated subsidy, however, will be the economic value of reduced congestion and fewer deaths because of decreased automobile and bus travel.**

- Energy consumption and pollution emissions are just about as likely to increase as they are to decrease when light rail systems are introduced. Light rail appears to use just about as much energy per passenger mile as automobile travel. Significant planned increases by 2016 in automobile mileage per gallon may make automobiles visibly more energy efficient than most light rail systems.

- The source of energy used to generate the electricity that powers a light rail system, along with regional topography and atmospheric conditions are important variables that help determine whether a system is able to improve energy consumption and pollution emission performance over an existing bus-only system.

- Typically, there is a positive economic impact enjoyed by some of the businesses and residences located near light rail stations, though the economic benefits generated by these systems are not widely shared by others who live in regions that have them. Higher-income property owners tend to capture most of these locational benefits.

The Tide Light Rail System

Source: Hampton Roads Transit website