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Review of Phoenix Comprehensive Transportation Plan

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Executive Summary

Urban transit plays an insignificant role in Phoenix's transportation life, carrying less than three-quarters of one percent of passenger travel and only about 3 percent of Phoenix workers to and from their jobs. Transit is so poorly suited to the Phoenix area that more workers who live in carless households use a car to get to work than use transit.

Yet public transit, especially light rail, plays a huge role in the minds of Phoenix political leaders, many of whom want to increase the current 0.4-percent transit sales tax by 75 percent to 0.7 percent. Although proponents call this a "comprehensive transportation plan," it is, in fact, a transit plan as funds for street maintenance and improvements, not counting transit-related improvements, amount to less than 3 percent of the proposed spending. Moreover, the proposed tax increase is really a new light-rail tax, as everything in the transit plan other than light rail can be funded at the current level of transit sales tax without a tax increase.

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According to the city of Phoenix and Valley Metro, light rail is a great success in Phoenix, generating a 42-percent increase in transit ridership since 2001 and stimulating the construction of $7 billion in new real estate development along its route. A close look, however, reveals that both of these claims are wrong.

The increase in ridership took place between 2001 and 2009, the (fiscal) year that the light-rail line opened. Since that year, for every light-rail rider gained, the region's transit systems lost more than one bus rider. Per capita transit ridership has declined by 8 percent since 2009 partly because the high cost of light rail forced a 34-percent increase in average bus fares by 2010 and an 18-percent decrease in bus service by 2013.

The transit plan offers no social benefit to counter its high cost, as it would increase traffic congestion, energy usage, and greenhouse gas emissions.

Meanwhile, the $7 billion in new real estate development turns out to be $6.9 billion in new development *plans*, nearly all of which were made before the financial crash that took place two months before the light-rail line opened. Many of these developments have never been built and at least half a billion dollars' worth of developments have been cancelled, as the claimed amount declined from $7.4 billion in 2009 to $6.9 billion in 2013.

Many of the projects that have been built were subsidized with low-income housing tax credits and other government programs, and it is possible that the subsidies (and the decisions by Phoenix, Tempe, and Mesa to subsidize projects along the light rail route) did more to stimulate the projects than the rail line itself. Most if not all of the remaining developments that were built would have been built even without the light rail. For example, Valley Metro counted construction of a new high school and expansion of the Phoenix Convention Center as developments stimulated by light rail; in fact, these would have happened even without the light rail.

The transit plan offers no social benefit to counter its high cost, as it would increase traffic congestion, energy usage, and greenhouse gas emissions. Phoenix's transit system as a whole uses more energy and emits more greenhouse gases per passenger mile than the average SUV. The city of Phoenix's fantasy of "reinventing Phoenix" by building denser housing along the rail line seems unlikely to be realized. It won't significantly reduce driving, and even if it did, it makes little sense to get people out of their cars and onto transit that is more expensive, produces less economic value, uses more energy, and emits more pollution than driving.

In the long run, the growth of car sharing combined with the imminent arrival of self-driving cars will make

most transit obsolete. Valley Metro should not waste billions of taxpayer dollars on long-term projects when the short run outlook for transit is so questionable.

Introduction

The city of Phoenix is proposing to extend the 0.4 percent sales tax dedicated to transit from its current expiration in 2020 to 2050, and further to increase it to 0.7 percent. The city expects that the higher tax will raise $17.3 billion over the next 35 years, or $7.4 billion more than if the tax remained at 0.4 percent. When combined with transit fares and federal grants, the city's transportation plan is projected to spend more than $30 billion through 2050.

Considering that most if not all of the debt service and reserve money is for light rail, about 40 percent of the funds will go for light rail or "high-capacity transit" (including interest payments on loans needed to build those lines); 52 percent for buses; and 7 percent for streets (table 1). Note that the cost of proposed new light-rail lines, plus debt service on those lines, is roughly equal to the $7.4 billion that would be raised through the tax increase. In other words, everything in the plan except building more light-rail lines can be accomplished by simply maintaining, rather than increasing, the sales tax.

Notice also that, of the 7 percent going for streets, most actually would go for "transit-related street improvements," not capacity improvements for cars. Even some of the 2.8 percent allocated to street maintenance could end up reducing street capacity for autos, as all street funds in the plan are grouped under "complete streets," which generally means expanding space for transit, bicycles, and pedestrians at the expense of space for autos.[1]

In other words, everything in the plan except building more light-rail lines can be accomplished by simply maintaining, rather than increasing, the sales tax.

Although the city calls this a "comprehensive transportation plan," it is, in fact, a transit plan, with 95 percent of the funds going for transit (including transit-related street improvements), 3 percent for streets, and 2 percent for public safety (not shown in table 1). Moreover, the numbers in table 1 are only a proposal, not a promise: the city has already tinkered with the numbers to some degree, and if planned light-rail lines suffer from the nearly inevitable cost overruns, it is likely that the result will be less money for streets, bus service, and other non-light-rail programs.

Table 1 . How Phoenix Would Spend Transportation Plan Dollars

PROGRAM	BILLIONS OF DOLLARS	PERCENT
Existing bus service	$11.69	34.6%
Expanded bus service	$5.04	14.9%
Future bus-rapid transit	$0.64	1.9%
Existing light rail	$1.99	5.9%
New light rail lines	$3.04	9.0%
New high-capacity transit lines	$5.51	16.3%
Other infrastructure	$0.54	1.6%
Transit-related street improvements	$1.48	4.4%
Street maintenance	$0.94	2.8%
Debt service & reserve	$2.90	8.6%
TOTAL	$33.77	100.0%

"Expanded bus service" includes increased frequencies and expanded hours for existing routes. "Other infrastructure" includes things like bus shelters, ADA enhancements, and GPS technology. Source: All costs except debt & reserve from Citizens Committee on the Future of Phoenix Transit Meeting Packet for February 4, 2015, Exhibit A. Debt & reserve from Brenna Goth, "How Phoenix Would Spend $31.7 Billion," Arizona Republic, March 10, 2015, tinyurl.com/qah4oy4.

This proposal has some significant imbalances. First, light rail currently carries less than 20 percent of the region's transit riders, yet receives (assuming that all high-capacity lines end up as light rail and the debt service all goes for light rail) more than 40 percent of transit spending. Second, the plan is significantly biased towards transit and away from autos, which would make sense as a transit plan but not as a "comprehensive transportation plan."

While this tax is only one part of an overall transportation program, these imbalances persist across the region. For example, the Maricopa Association of Governments' 2035 Regional Transportation Plan calls for spending more than 30 percent of available funds on transit systems that, as mentioned, carry less than 1 percent of the region's passenger travel (and virtually no freight).[2]

To help assess the proposed new transportation tax, this paper will review the Phoenix transit system with a special focus on light rail. The city argues that light rail has been successful because "since 2001, [transit] ridership has increased by 42% and 20 miles of light rail was constructed" and "total development investment made along the current light-rail line is approximately $7 billion." This paper will review those and other claims made about transit in general and light rail in particular.

1 Light Rail Does Not Stimulate Development or Promote Urban Growth

Valley Metro frequently claims that light rail has stimulated $7 billion dollars' worth of new development along its route. In fact, it is referring to development *plans*, not to developments themselves. Many of the plans have never been built and many may never be completed. Moreover, virtually all of any actual development would have happened anyway without

the light rail, though some of it might have taken place elsewhere in the city or urban area. That means that the new development along the rail line generated zero net new tax revenues and zero net new jobs.

Valley Metro's claim of $7 billion of new development along the rail line is simply untrue. This claim appears as early as fall 2009 in a city of Mesa newsletter saying that "non-rail investment near the light-rail route has reached $7.4 billion, most of which has been private ($5.9 billion private, $1.5 billion public)."[3] In 2010, *Progressive Railroading* reported that, "Since its opening, light rail has brought $7 billion worth of economic development to the corridor," citing Valley Metro CEO Steve Banta as a source.[4]

The claim is repeated in a Valley Metro press release on March 28, 2011, only the press release says, "the line has also attracted $7 billion in public and private development since 2004" rather than "since its opening."[5] Four years later, Valley Metro's *Five-Year Strategic Plan*, dated January 22, 2015, says, "Valley Metro Rail cost $1.4 billion to build and has generated $6.9 billion in neighboring economic development."[6] Note that, between 2009 and 2015, the amount of claimed development has gone from $7.4 billion to $6.9 billion. If the early developments had been successful, they should have led to more development, not less.

Valley Metro's claim of $7 billion of new development along the rail line is simply untrue.

Valley Metro documents published in 2009 and 2013 are more specific. They identify not actual construction but "recently completed, under construction, and planned projects" from "2001–present." The 2009 document says there were 180 such projects totaling $7.387 billion, of which $1.523 billion was public funds and $5.864 billion was private funds. The 2013 document says there were 169 projects include $1.48 billion in public spending and $5.39 billion in private spending for a total of $6.87 billion.

The 2009 and 2013 documents each provide some details about five of the projects as examples. At least one of the projects listed in each document—Escala on Camelback in 2009 and Sycamore Station Apartments in 2013—were apparently never completed.[7] At least some of the completed projects appear to have been funded with the help of low-income housing tax credits and other subsidies.[8]

In other words, there has not been $7 billion of economic development since the rail line opened or even since planning began for the rail line. Instead, there have been $6.9 billion of economic development *plans*, some of which have been completed but others of which are still in the planning stages and at least

eleven have apparently been cancelled given that the claim has shrunk from 180 to 169 projects. Note that 92 percent of the decline from $7.4 billion to $6.9 billion was in private plans.

Does anyone outside of Valley Metro really think that the convention center wouldn't have been expanded were it not for the light rail?

Most of the plans for these developments were probably made before the 2008 crash, when speculators had driven up prices for Phoenix-area condominiums and other housing. Some of the developments may have been completed after the crash because contracts had been signed and it was too late to stop despite the dramatic drop in condominium prices or because subsidies made it worthwhile for developers to complete the projects despite the fall in housing prices. For example, construction began on one of the four completed developments in the 2013 document, CityScape, in October 2008, the month of the financial crash and two months before the light-rail opened.

Site of the defunct Sycamore Station development, one of many failed projects still cited as "economic development" along the light rail.

It is also clear that no new plans have been made in the five years since 2009, when the $7.4-billion-talley was made. This can be blamed on the recession but could also be due to saturation of the market for multifamily housing that had been created by the speculative boom that preceded the crash.

Of the developments that have been built since the light-rail opened, it is likely that most if not all would have been built without the light rail anyway. For example, among the developments that Valley Metro credits to the light rail are the $600 million expansion to the Phoenix Convention Center and the Robert Duffy High School.[9] Does anyone outside of Valley Metro really think that the convention center wouldn't have been expanded or the new school wouldn't have been built were it not for the light rail?

Other cities, such as Portland and Denver, that claim that light rail has stimulated new development never mention the large subsidies they give to development along their rail lines. Portland, for example, has given out more than $1.4 billion in subsidies to development along its rail lines, and Portland suburbs have given out even more.[10] Most of these subsidies are funded

through tax-increment financing, and Reinvent Phoenix documents lament that tax-increment financing isn't legal in Arizona.[11] In its place, Phoenix, Tempe, Mesa, and other government agencies are using low-income housing subsidies, below-market sales of government land, and low-interest sustainability loans to subsidize development along the light-rail line.

To the extent that anything has been built along the rail line at all, it doesn't mean that the rail line has increased the overall value of Phoenix-area real estate. To do so, the rail line would have had to increase the economic growth of the Phoenix area, yet several studies have shown that rail transit doesn't promote urban growth. At best, it shifts it around to different parts of an urban area; at worst, the tax burdens posed by rail transit actually slow urban growth.

For example, a study by University of California (Berkeley) planning professors John Landis and Robert Cervero found that, 25 years after the opening of San Francisco BART lines, population densities actually decreased closer to BART stations due to the lack of new development near those stations. "Population has grown faster away from BART than near it," they say, concluding that "the land use benefits [and by "benefits" they mean increased population densities] of investments in rail are not automatic."[12] Cervero has long been an advocate of rail transit and transit-oriented development, having co-authored a 1996 book titled *Transit Villages in the 21st Century*.[13]

The Federal Transit Administration asked Cervero and Parsons Brinckerhoff consultant Samuel Seskin to do a literature review regarding the effects of rail transit on urban growth and form. Based on their review of the literature, Cervero and Seskin concluded that "urban rail transit investments rarely 'create' new growth, but more typically redistribute growth that would have taken place without the investment." The main redistribution was from the suburbs to "downtown, in the form of redeveloped land and new office, commercial, and institutional development." Further, the examples they cited of rail transit that influenced the location of urban growth were rail systems that move tens of thousands of workers to downtown jobs, such as those in San Francisco, Toronto, Washington, and New York, and not those in cities that have few downtown jobs.[14]

This makes it appear that rail transit is, at best, a zero-sum game; that is, every gain for property owners along the rail lines is offset by losses for property owners elsewhere in the urban area. But a close look at

transit spending and urban growth suggests that it is potentially a negative-sum gain: that is, that spending lots of money on transit capital improvements actually slows urban growth, probably because of the increased tax burden required to support transit spending. As table 2 shows, when considering the nation's 64 largest urban areas and its 160 largest areas, all correlations between transit spending and growth are negative, and the strongest correlations are between capital spending in the 1990s and population growth in the 2000s and between operational spending in the 1990s or 2000s with population growth in the 2000s.

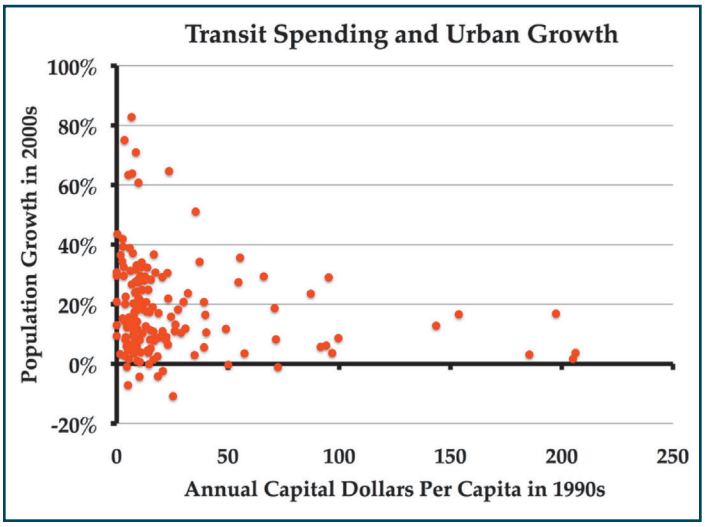
Table 2 . Correlations Between Per Capita Transit Spending and Urban Area Growth

CORRELATIONS	64 URBAN AREAS	160 URBAN AREAS
1990s Capital Spending & 1990s Growth	-0.09	-0.04
2000s Capital Spending & 2000s Growth	-0.07	-0.09
1990s Capital Spending & 2000s Growth	-0.23	-0.18
1990s Operating Spending & 1990s Growth	-0.19	0.00
2000s Operating Spending & 2000s Growth	-0.26	-0.21
1990s Operating Spending & 2000s Growth	-0.30	-0.21

Source: Calculations based on National Transit Database historical time series for capital and operational spending and 1990, 2000, and 2010 census data for urbanized area populations. Census data have been corrected to account for Census Bureau lumping and splitting of some urban areas between census years.

Figure 1, showing per capita capital spending on transit in the 1990s and population growth in the 2000s, reveals something else: without exception, the fastest-growing urban areas in the 2000s were the ones that annually spent less than $50 per capita on transit capital improvements in the 1990s, while without exception that ones that annually spent more than $100 per capita on transit capital improvements in the 1990s were among the slowest-growing urban areas in the 2000s. This suggests that, while there is no guarantee that spending less on transit will promote urban growth, spending more on transit could hinder urban growth.

Figure 1 . Transit Spending and Urban Growth



Out of 160 major urban areas, the fastest-growing urban areas in the 2000s (upper left portion of the chart) spent the least on transit capital improvements in the 1990s. On the other hand, those that spent the most on transit capital improvements (lower right portion of the chart) ended up among the slowest-growing urban areas. Source: U.S. Census data for urbanized areas; capital expenditures from the National Transit Database.

2 Ridership Fell After Phoenix's Light-Rail Line Opened

Across the nation, light-rail projects that receive federal support have followed a familiar pattern. First, the transit agency proposes a line and estimates the cost. After the agency gets political and community leaders to buy into the project, the cost rises. By the time it is finally built—often years late—the project ends up costing far more than originally projected. Despite this, transit officials misleadingly claim it was finished on time and on budget.

Soon after (and sometimes even before) the rail line opens, the high cost puts a strain on the transit agency's finances and the agency responds by some combination of fare increases and cutbacks in bus service. The light-rail line may or may not prove to be popular, but the overall transit system suffers, with ridership growth slowing or even shrinking. This pattern has been followed in Portland,[15] San Jose,[16] and many other cities.

The history of the Valley Metro light-rail line followed this pattern almost perfectly. In 1998, the Federal Transit Administration reported that the first 13 miles of Phoenix's light-rail line would cost about $30 million per mile (see table 3). Costs quickly rose so that by 2000, the entire 20-mile line was expected to cost $53 million per mile. In 2004, the projected cost had grown to $72 million per mile. However, the actual amount spent on planning, engineering, design, and construction ended up being $96 million per mile. Although most references to the project claim that its final cost was $1.4 billion, Federal Transit Administration records show that actual expenditures on light rail between 1999 and 2009 were closer to $1.9 billion.[17]

All of these figures are "year-of-expenditure" dollars, meaning they aren't adjusted for inflation, but inflation between 1998 and 2009 would only account for a small portion of the tripling in per-mile costs during that time. The figures don't include interest on bonds sold to pay for the project. In 2004, the City of Phoenix Civic Improvement Corporation offered $500 million worth of bonds that were expected to pay $274 million in interest.[18] If those bonds were all sold and interest paid as scheduled, adding the interest charge increases the final cost per mile to $110 million.

Table 3 . Projected and Actual Phoenix Light-Rail Costs

YEAR	COST	MILES	COST / MILE
	(dollars in millions)		
1998	$390	13.0	$30
1999	$884	18.5	$48
2000	$1,076	20.3	$53
2001	$1,181	20.3	$58
2002	$1,184	20.3	$58
2003	$1,377	20.3	$67
2004	$1,412	19.6	$72
2005	$1,412	19.6	$72
FINAL	$1,880	19.6	$96

Costs and cost/mile are in millions of dollars. The "final" cost includes all dollars spent by Phoenix, Tempe, and Valley Metro in planning and building the line between 1999 and 2009 with no adjustments for inflation. Sources: 1998 through 2005 numbers are from the Federal Transit Administration's annual "New Starts" reports (which are dated two years after they are written, thus the 1998 numbers are from the 2000 New Starts report); final data is based on actual capital expenditures reported in the National Transit Database.

The Federal Transit Administration's National Transit Database reports that Valley Metro spent $283 million on rail capital expenses in 2003 and 2004, probably for engineering and design work as construction on the project didn't officially begin until March 2005. The original planned opening date of December 2006, was delayed until December 2008.[19] Despite the two-year delay and the tripling in costs, Valley Metro misleadingly proclaimed that the project was "on time and on budget."[20] This could be considered merely misleading rather than lying, as the project was on time and on budget using the last timetable and budget prepared for it, just not using any earlier ones.

The increased cost of the Phoenix light-rail project was predictable, as nearly all of the light-rail lines built in the United States since the mid-1980s have suffered similar cost overruns. A series of reports on projected and actual costs published by the Department of Transportation between 1990 and 2013 found only one light-rail line whose per-mile cost proved to be no more than the original estimates. After adjusting for inflation, the average final cost of light-rail projects was 34 percent greater than the original projections, and results showed no signs of improvements over time.[21]

As previously noted, the city proudly claims that transit ridership has increased by 42 percent since 2001. What it doesn't say is that all of the increase took place between 2001 and 2009, the fiscal year that the light-rail line opened, after which ridership declined. The city may blame the decline after 2009 on the recession, but at least two other factors are involved.

Following the pattern, fares increased so that average bus revenues per trip rose by 34 percent (adjusted for inflation) between 2009 and 2010. At the same time, bus service (measured in vehicle revenue miles) was cut back by 5 percent. Bus service declined another 13 percent between 2010 and 2013, for a total 18 percent cut since the year the light rail opened.[22] Although some might expect bus service to drop as some bus lines are replaced by light rail, in fact those lines are usually turned into frequent feeder bus routes for the

light rail, which would mean an increase in revenue bus service if the system were properly managed.

The fare increase and cuts in bus service contributed to a significant drop in bus and rail ridership, from nearly 76 million trips in 2009 to 66 million in 2010 (not counting vanpools or dial-a-ride but counting buses provided by Glendale, Phoenix, Scottsdale, Tempe, and Valley Metro as well as light rail). Ridership slowly recovered after 2010, but by 2013, ridership was still 1.2 million less per year than in 2009.[23] Early results from the American Public Transportation Association indicate that rail ridership grew slightly in 2014 but this growth was more than offset by further declines in bus ridership.[24]

In short, between 2009 and 2014, every light-rail rider gained was offset by the loss of more than one bus rider. In that time, both population and jobs had grown, so that the number of trips carried per resident fell by 8 percent between 2009 and 2013, while the number of trips per worker fell by 15 percent.

While the recession no doubt played a role in the large drop in ridership between 2009 and 2010, rail transit makes transit agencies more vulnerable to the effects of recessions. This is because rail construction requires most agencies to go heavily into debt, while agencies rarely have to borrow money to buy new buses.

If a transit agency that has no debt suffers a 10 percent decline in tax revenues used to subsidize the system, it might respond by reducing service by 10 percent. But an agency that has to dedicate half its tax revenues to debt service would have to respond to a 10 percent drop in revenues by either defaulting on the debt or reducing service by around 20 percent. In this case, as noted above, the Phoenix Civic Improvement Corporation borrowed as much as $500 million to help pay for light-rail construction.

In short, between 2009 and 2014, every light-rail rider gained was offset by the loss of more than one bus rider.

Phoenix had to borrow more than would otherwise have been necessary due to the cost overruns that almost invariably take place with rail projects. The federal government will normally pay up to half the costs of new rail construction, but it will rarely pay a share of cost overruns after it signs what is known as the "full funding grant agreement." The agreement for the Phoenix rail line was signed when the cost was projected to be less than $1.2 billion, so Phoenix-area taxpayers had to pay well over half of the final cost of the light-rail line as well as the interest and other debt-servicing costs on that share of the project.

While it was a coincidence that the light-rail line opened just a few weeks after the 2008 financial crisis, given the ups-and-downs of the business cycle,

at some point tax revenues would be certain to fall below expectations. Borrowing heavily to build light rail when buses could have provided similar service without borrowing meant that the kind of service cuts and fare increases that took place after 2009 were inevitable at some point.

3 Transit is Irrelevant to Most Phoenix-Area Residents

It might be appropriate to spend 30 percent of transportation funds on transit in the New York urban area, where transit carries 11 percent of all passenger travel and nearly 33 percent of all commuters to work. But Phoenix is very different from New York.

In 2013, Phoenix-area transit carried 372 million passenger miles of travel.[25] By comparison, Phoenix-area roads carried 81.4 million vehicle miles of travel per day, or 29.7 billion per year.[26] According to surveys by the U.S. Department of Transportation, the average car has 1.67 occupants.[27] At this occupancy rate, the roads produced nearly 50 billion passenger miles of travel in 2013. A few of the vehicles are trucks, most of which presumably have only one occupant, but these are offset by buses that have many occupants.[28]

Transit therefore carries around three-fourths of one percent of motorized passenger travel in the Phoenix area. Light rail carries just 26 percent of transit passenger miles, or less than 0.2 percent of all motorized passenger miles. When bicycling and walking are added, transit is even less significant.

Transit tends to be more heavily used for commuting than for other forms of travel. The Census Bureau's American Community Survey found that fewer than 48,500 of the 1.68 million workers in the Phoenix urban area—less than 3.1 percent—took transit to work in 2013, while 87 percent used autos. Far more workers—95,500, or 5.7 percent—work at home than take transit to work.[29] Similarly, for the city of Phoenix alone, more than 580,000 people (86.7 percent) took cars to work in 2013, compared with fewer than 27,000 (4.0 percent) who took transit and more than 30,000 (4.6 percent) who worked at home.[30]

The actual number of people who take transit to work on any given day may even be lower than these numbers indicate. The Department of Transportation's National Household Travel Survey found that people who tell census takers that they usually take transit to work sometimes drive, while people who say they usually drive almost never take transit.[31] Adjustments based on this survey would reduce transit's numbers by 23 percent. While the results may differ for Phoenix than for the nation as a whole, it is likely that the number of Phoenix workers who take transit to work on any given day is below 27,000 and that transit's share is less than 4 percent.

Historically, transit's market has mainly been among people who don't have cars, but that market has nearly disappeared. According to the American Community Survey, only 2.8 percent of workers in the Phoenix urban area and only 4.0 percent in the city of Phoenix live in households that have no cars, while more than three out of four workers in the Phoenix urban area and nearly three out of four in the city of Phoenix live in households with two or more cars.[32]

Not only is the market of car-less people very small, Phoenix transit hasn't been successful in attracting most people who live in households without cars to take transit to work. Of workers who live in households with no cars, less than 34 percent in the city of Phoenix (38 percent in the Phoenix urban area) took transit to work in 2013, while more than 38 percent (41 percent in the Phoenix urban area) drove alone, perhaps in vehicles supplied by their employers, or carpooled.[33] This suggests that Phoenix jobs are so spread out that transit doesn't even work for most people without cars.

In response to the shrinking number of car-less households, the transit industry has shifted focus to getting people out of their cars and onto transit. Supposedly this has some great social value other than maintaining transit subsidies, as advocates claim that transit provides social benefits such as saving energy and reducing greenhouse gas emissions.

Phoenix-area transit uses far more energy and emits more greenhouse gases per passenger mile than an average SUV.

In fact, Phoenix-area transit uses far more energy and emits more greenhouse gases per passenger mile than an average SUV. In 2013, Phoenix-area transit used more than 4,850 British thermal units (BTUs) and emitted 336 grams of carbon dioxide per passenger mile.[34] By comparison, in 2012 (the latest year for which numbers are available), the average car used less than 3,200 BTUs and emitted about 224 grams of carbon dioxide per passenger mile, while the average light truck (pick-ups, SUVs, and full-sized vans) used less than 4,000 BTUs and emitted about 280 grams per passenger mile.[35] Automobiles are rapidly becoming more energy efficient, and transit in Phoenix is already less environmentally friendly than driving.

Phoenix light rail uses less energy and emits less carbon dioxide per passenger mile than buses. But light rail does not exist in a vacuum; it must be supplemented by an extensive feeder bus network that uses lots of energy per passenger mile. Light-rail construction also uses enormous amounts of energy and emits greenhouse gases, and since light rail is less heavily used than roads, the energy cost of construction per passenger mile is much higher than for highway travel. One study found that the life-cycle energy cost of rail transit was 155 percent greater than

the operating cost, while the life-cycle energy cost of buses and cars was only 63 percent greater.[36]

Nor does transit do much to reduce congestion. Since there are so few transit riders, if every transit rider were to switch to driving, the impact on Phoenix-area traffic would be negligible. A huge increase in ridership would be needed to produce a discernible effect on congestion, and few if any transit systems in America have ever been able to produce such an increase. Only one major urban area—Las Vegas—has managed to double transit's share of commuting since 1990, and it did it solely with buses, not by building rail transit.

4 Phoenix is Unsuited to Big-Box Transit

Phoenix's proposed light-rail network is an attempt to substitute "big-box" transit—light-rail trains capable of moving hundreds of people at one time—for medium-box transit—buses capable of moving 40 to 120 people at a time. But this is the wrong direction to go in modern urban areas where jobs and people are widely scattered across the landscape.

Phoenix is one of the most dispersed urban areas in the world, so much so that people who have a nineteenth-century notion of what a city should look like disparagingly argue that Phoenix isn't a real city at all. In fact, the nineteenth-century city, with a dense downtown employment center surrounded by lower-density residential areas, is historically the exception rather than the rule. As *Edge City* author Joel Garreau says, "We built cities that way for less than a century," making them more "aberrations" and "relics" than the model modern cities should follow.[37]

Transit usage is less influenced by overall population density than by the concentration of jobs at the urban core.

Many people believe transit ridership is a function of population density. In fact, transit usage is less influenced by overall population density than by the concentration of jobs at the urban core.[38] For example, at 7,000 people per square mile, the Los Angeles urban area is significantly denser than the 5,300 people per square mile in the New York urban area (which includes Long Island and northern New Jersey). Yet New York's transit system carries more than 32 percent of commuters compared with just 6 percent in Los Angelesc because New York has nearly 2 million jobs concentrated in about 7 square miles of Manhattan, compared with less than 137,000 jobs in downtown Los Angeles.[39]

The 2010 census found that the Phoenix urban area has about 3,165 people per square mile, which is well below New York, San Francisco, and other urban areas with heavy transit use.[40] But Phoenix is even less suited for big-box transit by the jobs standard, as it had (as of 2006) just 26,225 downtown jobs. Many other Phoenix-area jobs are in various edge cities,

such as Scottsdale Airpark and Biltmore. But most of Phoenix's 1.7 million jobs are scattered around so thinly that neither big- nor medium-box transit work for the vast majority of commuters (which is, of course, why they don't use it).

Even concentrating jobs would do little to increase transit commuting unless those jobs are concentrated at the hub of a hub-and-spoke transit system. Downtown Los Angeles—at the hub of most of the region's rail lines—and the Los Angeles Airport-El Segundo area—at one end of one of the region's rail lines—each have about 136,000 jobs, yet 22.5 percent of downtown commuters take transit to work while less than 9 percent of airport-area commuters use transit.[41]

Phoenix's response to low transit ridership is to "reinvent Phoenix" with *transit-oriented developments*, that is, the concentration of housing in transit corridors and near light-rail stations. But there are several flaws to this strategy. First, the demand for such housing is limited, and once saturated new developments will go bankrupt unless heavily subsidized. Second, even if built, such developments do not significantly alter people's travel habits. Instead, studies show that people living in such developments drive as much, or nearly as much, as people living elsewhere. Third, even if this strategy could reduce driving, the reduction in personal mobility would have a negative impact on the region as a whole.

Documents distributed by the city of Phoenix show the "projected demand" for housing in transit-oriented developments rising exponentially in the future.[42] In fact, while there is a demand for such housing, it tends to be small and there is no reason to think it will increase any faster than the demand for single-family homes. Those who say it will are engaged in wishful thinking based on several logical fallacies.

Most surveys show that 75 to 85 percent of Americans aspire to live in single-family homes while only 15 to 25 percent want to live in multifamily housing even if that housing has better access to transit than single-family neighborhoods.[43] Even most Millennials aspire to live in single-family homes even if, due to the economy, many live in apartments today.[44] What is notable is that nearly all of the people who want to live in multifamily housing have no children in their households. Proponents of transit-oriented developments make the false conclusion that growing numbers of childless households, including "empty nesters" and young Millennials, mean that far more people will want to live in transit-oriented developments.[45] In fact, census data show that the vast majority of retiring Baby Boomers and Millennials live in the suburbs.[46] Moreover, surveys show most Millennials who now live in multifamily housing aspire to move to single-family homes as soon as they can afford to do so.[47]

Another fallacy behind the "projected demand" for transit-oriented development is the misuse of the term "demand." Demand is not a single quantity, as portrayed on the chart in Phoenix's document, but a relationship between price and quantity. Phoenix and other transit-oriented development proponents say nothing about price, but the cost of constructing mid-rise multifamily housing is greater, per square foot, than for single-family housing.[48] Moreover, land prices tend to be more in commercial areas (where transit-oriented developments are typically built) because of competing uses for that land. This means that future home seekers will have a choice of living in a small but expensive multifamily unit on a transit line and a larger yet less-costly single-family home that may be two or three blocks from a transit line. When price enters the equation, even those who say they aspire to live in a transit-oriented development can find their choices significantly change.

The second problem is that Phoenix assumes that transit-oriented developments will lead people to drive significantly less and use transit more. This is unlikely unless Phoenix manages to concentrate several hundred thousand jobs at the hub of its transit system, which isn't a part of its plans and probably could not be accomplished.

Several studies have found that commuting and travel choices made by people living in transit-oriented developments are not significantly different from people living elsewhere.[49] For example, a study of transit-oriented developments in the Portland urban area, where transit carries about 7.3 percent of commuters to work, found that 2 to 13 percent of people leaving various transit-oriented developments during morning rush hours used transit, and in most cases it was well under 7.3 percent.[50]

To the extent that there are differences in travel choices in transit-oriented developments, they are mainly due to self-selection: that is, people who want to drive less choose to live in such developments, rather than that the developments themselves change people's travel choices. After accounting for self-selection, University of California (Irvine) economist David Brownstone concluded, the effect of density on transportation is "too small to be useful" in reducing congestion or saving energy.[51]

The third problem with reinventing Phoenix is that, even if the plan could shift large numbers of people from cars to transit, it isn't clear why this is a desirable social goal. Transit is a far more costly and less energy-efficient form of travel than autos, and to make transit competitive at all, it must be heavily subsidized.

While there are subsidies to highways, they are small and virtually all at the local level. Arizona state highways receive no appropriations from general funds and are mostly paid for out of gas taxes and other user fees.[52] Arizona cities and counties spent around $650 million in general funds on roads and streets

in 2012, a year in which people drove about 8 billion miles on local roads in the state.[53] This represents an average subsidy of 8 cents per vehicle mile or, at an average occupancy of 1.67 people per vehicle, about 5 cents per passenger mile. By comparison, subsidies to Valley Metro light-rail transit are more than $1 per passenger mile while subsidies to bus transit are around 90 cents per passenger mile.

Transit's inconvenience and slow speeds relative to driving mean that people who depend on transit are much less mobile than people who drive. Mobility itself has a value, as it provides access to greater economic, social, and recreational opportunities such as better jobs and lower-cost consumer goods. Studies show, for example, that faster commute speeds translate to greater worker productivities. Based on these studies, says economist Rémy Prud'Homme, urban transport policy should aim primarily "at increasing the effective size of urban labor markets."[54]

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While automobiles provide most Phoenix-area residents ready access to hundreds of thousands of jobs, transit allows people to reach only a small fraction of those jobs in the same or even double the travel time. Since transit is slower than driving, a passenger mile of transit gives access to fewer economic opportunities than a passenger mile by car, and thus transit is less economically valuable despite its higher cost.

5 Subsidies to Light-Rail Riders are Greater Than to Bus Riders

Phoenix light-rail operating costs per passenger are lower than bus costs. But when the capital and maintenance costs are added, light rail becomes significantly more expensive than buses. This expense is made worse by low fares collected from light-rail riders. Because the average light-rail trip is a longer than the average bus trip—nearly 7 miles vs. 4 miles—the appropriate measure of comparison is cost and revenue per passenger mile.

According to the 2013 National Transit Database, Valley Metro collected just 13 cents per passenger mile from light-rail riders, compared with 22 cents from bus riders. The light-rail fare is well below the national average of 21 cents per passenger mile, suggesting that Valley Metro is either charging unusually low fares in order to attract riders (a policy it isn't applying to buses) or is overestimating light-rail ridership.[55]

Fares covered only a portion of operating costs, which were 29 cents per passenger mile for light rail and 94 cents per passenger mile for buses. One reason for the large difference is that the light-rail line was built on a heavily-used route, while many bus routes are

lightly used. The cost per passenger mile of buses on a heavily-used route would be significantly lower.

The problem for buses is that Phoenix has a lot of buses that operate nearly empty. While the average light-rail car carries 40 people (that is, passenger miles divided by vehicle revenue miles is about 40), the average Phoenix bus carries just 8. Per vehicle mile, buses cost only about two-thirds as much to operate as light rail, which means they only need to carry two-thirds as many riders to have operating costs as low as light rail.

Out of more than 100 Valley Metro bus routes, just 11 carried half of all the region's transit riders in 2013.[56] Per passenger mile, these buses probably cost less to operate than light rail, and a few might even produce an operating profit. If it hadn't been replaced by light rail, a Phoenix-Tempe bus would likely have been among those eleven.

Even if bus operating costs were greater than light rail, this higher cost is more than offset by rail's higher capital costs. Light-rail costs can be allocated to passenger miles by amortizing the costs (using standard mortgage formulae) over the lifespan of the project. While railcars have an expected lifespan of 25 years, most other rail infrastructure has an expected lifespan of 30 years, so that number will be used here.

Until 2010, the Federal Transit Administration specified that projects be amortized using a 7 percent interest rate. In 2010, that was changed to 2 percent. While 7 percent is too high, 2 percent is probably two low as the current cost of borrowing under the

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Transportation Infrastructure Finance and Innovation Act (TIFIA) is closer to 3 percent. At 2 percent, the annualized cost of every million dollars of capital costs is $44,354. At 3 percent, it is $50,592, while at 7 percent it is $79,836.

Although the "official" cost of the light-rail line was about $1.4 billion, Phoenix and Valley Metro actually spent $1.57 billion in capital costs between 2005, when construction began, and 2009, when it was completed. They spent another $309 million prior to 2009 on planning, engineering, and design. At 2 percent, this total cost works out to about $83 million per year or 85 cents per passenger mile. At 3 percent, it is 97 cents per passenger mile, while at 7 percent it is $1.54 per passenger mile.

A third cost is maintenance, which isn't included in operating costs. As of 2013, Valley Metro spent 3 cents per passenger mile on light-rail maintenance but this is likely to increase over time. For rail lines, these costs start out low and increase as the line ages. By the time the line reaches the end of its expected lifespan—in

other words, about 30 years—maintenance becomes very costly and much of the line requires complete replacement. Few transit agencies budget for this, which is why the Federal Transit Administration found in 2010 that rail transit agencies had a $59 billion backlog of deferred maintenance, a backlog that has grown since then because transit agencies weren't spending enough to keep it from growing, much less to shrink it.[57]

For example, Portland's earliest light-rail line opened in 1986 and began experiencing serious maintenance problems by the time it was 28 years old. A 2014 audit by the Oregon Secretary of State found that Portland's transit agency was only spending 53 percent as much as needed to keep its light-rail tracks in good repair and only 72 percent as much as needed to keep signals in good repair.[58] As a result, Portland's light-rail lines suffer frequent delays from breakdowns. In May 2013, Portland's transit agency tweeted an apology to riders for having breakdowns three times in three days. Within 22 minutes of the apology, the system suffered another breakdown.[59]

In the case of buses, a transit agency may buy a large number of buses one year, then not buy many for several more years. Fortunately, the National Transit Database has capital cost data going back to 1992. After adjusting for inflation, Valley Metro spent an average of $22.9 million per year on bus capital and maintenance costs, which in 2013 works out to 15 cents per passenger mile.

Together, light-rail capital, maintenance, and operating costs add up to $1.18 per passenger mile at the 2 percent interest rate and $1.30 at the more reasonable 3 percent rate. Bus costs averaged $1.09 per passenger mile. Because of higher average bus fares, subsidies to bus riders averaged just 97 cents per passenger mile compared to $1.05 (at 2 percent) to $1.17 (at 3 percent) for light rail. Counting all buses in the Phoenix area, buses cost less than light rail. Counting only buses on heavily used routes that are likely candidates for light rail, buses probably cost less than half as much, per passenger mile, as rail.

6 Phoenix Light Rail Does Not Relieve Congestion

Rail proponents often claim that light rail will relieve traffic congestion. Since auto drivers benefit from the reduced congestion, proponents continue, those drivers should be willing to subsidize rail construction.

Phoenix's light rail clearly has not relieved congestion to date. After the opening of the light rail, the region lost more bus riders than it gained in rail riders. This means that virtually all rail riders were previously bus riders. (Some may not have been, but they were effectively offset by people who stopped riding the bus

due to increased fares, reduced service, or other factors.) This is in line with research showing that, in America's largest urban areas, "increasing transit utilization does not lead to a reduction in traffic congestion; nor does decreasing transit utilization lead to an increase in traffic congestion," mainly because transit is used so little in all but a handful of those urban areas.[60]

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Rail proponents may blame the decline in ridership on the recession, but not even the optimistic predictions made before the light rail was built indicated that it would reduce congestion. As critic John Semmens noted in 2005, the environmental impact statement for the rail line predicted that it would remove one car out of every 750 from traffic in the rail corridor. To do so, however, it would take out two lanes of traffic. This would reduce average traffic speeds from 17.9 to 17.7 miles per hour.[61]

Light rail increasing rather than reducing congestion seems to be the rule, not the exception. Rail transit can increase congestion by occupying street space that would otherwise be open to cars. Anaheim proposed a streetcar line that was projected to remove, at most, fewer than 300 cars per hour from city streets—but the streetcars themselves would occupy enough street space to reduce the capacity of those streets to handle traffic by nearly 1,100 cars per hour.[62]

Light rail also often crosses streets at grade, and the frequency that it does so can increase congestion. Most cities give light-rail cars priority over most other traffic at traffic signals. This disrupts signal coordination systems, spreading the congestion-building effects of rail well beyond the intersections the rail lines cross.

For example, the Hiawatha light-rail line between Minneapolis and Bloomington never crosses Hiawatha Avenue (state highway 55) at grade, but it parallels that road and crosses many streets that, in turn, cross highway 55. Because the light rail had priority at traffic signals on those cross streets, and because the cross street traffic signals were coordinated with the signals on Hiawatha, the opening of the light rail increased auto travel times between Bloomington and Minneapolis by 20 to 40 minutes.[63]

Due to the combination of these effects, the traffic analyses that have been done for light-rail lines generally conclude that they increase congestion. For example, the traffic analysis for the Purple Line in suburban Washington, DC found that, with the light rail, regional traffic speeds in 2030 would average one-tenth of a mile per hour slower than without the light rail.[64] That tenth of a mile per hour represents 36,000 hours of wasted travel time per day, or more

than 12 million hours per year. A similar analysis for the Red light-rail line proposed for Baltimore found that it would reduce average traffic speeds by two-tenths of a mile per hour.[65]

If transportation funding were fair, rather than auto drivers helping to pay for light-rail construction, light-rail riders should have to pay auto drivers for the increased congestion their mode of transit imposes on the roads.

7 Light Rail is Low-Capacity Transit

Valley Metro frequently calls light rail "high-capacity transit," implying that it can carry more people than buses. Light rail is big-box transit, meaning a single train can carry a lot of people assuming all those people want to go at the same time. But light rail is definitely not high-capacity transit, because a light-rail line cannot move large numbers of people per hour.

In fact, light rail is by its very name low-capacity transit. The term "light" does not refer to weight; light-rail cars actually weigh more than heavy-rail cars. Instead, it refers to capacity: as defined by the American Public Transportation Association, light rail means "an electric railway with a 'light volume' traffic capacity compared to heavy rail."[66] In short, the phrase "high-capacity light-rail transit" paradoxically means "high-capacity low-capacity rail transit."

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The distinguishing feature between light rail and heavy rail is that most light-rail lines sometimes enter or cross city streets while heavy rail always operates in exclusive rights of way. Heavy-rail trains can be as long as the platforms built for them, which usually means eight to eleven cars long. Light-rail trains cannot be longer than a city block; otherwise, they would block traffic every time they stopped for passengers. In Phoenix, this means trains can only be three cars long.

In addition, for safety reasons, trains must be spaced several minutes apart. Many heavy-rail lines have sophisticated signals that allow as many as 30 trains per hour. Most light-rail lines can handle no more than 20 trains per hour. If a line forks, then each fork can only take a portion of those trains. For example, Portland has a line that crosses a bridge signaled for 30 trains an hour (which is possible because there are no stops on the bridge). The line forks into two lines on the west side of the bridge and four lines on the east side. Because of the bridge's capacity limit, the four east side lines can average no more than 7.5 trains per hour.

A typical light-rail car has about 70 seats and is rated to hold another 120 people standing. But this requires a level of crowding that most Americans find unacceptable. In practice, a total capacity of about 150 people is more reasonable. A route that can support 20 three-car trains per hour therefore can move about 9,000 people per hour.

By comparison, a standard, 40-foot bus typically has about 40 seats and can comfortably hold about 20 more people standing. A single bus stop can support about 42 buses per hour.[67] Forty-two buses times 60 passengers is 2,520 people per hour, considerably less than light rail.

However, bus capacities can be increased in several ways at very little cost. First, some Portland streets have staggered bus stops with two stops per block. Every bus stops every other block, or every fourth stop, thus allowing as many as 168 buses per hour. In actual practice, Portland has scheduled as many as 160 buses per hour on these streets.[68] This boosts capacity to 9,600 people per hour, more than light rail.

Second, many buses can hold more people than standard, 40-footers. Many cities own 60-foot, articulated buses (sometimes called "bendy buses") that typically have 60 seats and are rated for 60 people standing (though 30 is a more practical limit). That means they can move 14,400 people per hour on a city street with staggered bus stops. Even bigger are double-decker buses with 85 seats and room for at least 40 people standing, yet are not significantly longer than a standard, 40-foot bus. These buses take longer to load and unload so work best as longer-distance commuter or express buses that make fewer stops.

Bus-rapid transit systems can move even more people per hour. Although there are many kinds of bus-rapid transit, the most important distinguishing feature is that the buses operate more frequently and stop less frequently than conventional bus routes. While a conventional bus may operate two to four times per hour and stop around six times per mile, a bus-rapid transit line would operate four to eight times per hour and stop only about once per mile. In other words, bus-rapid transit has about the same frequencies and number of stops as a typical light-rail line.

Beyond this, bus-rapid transit can have several additional features that increase speeds, capacities, and attractiveness to potential passengers. Speeds can be increased by using buses with wide doors to allow more rapid entry and exit; building platforms at bus stops so passengers don't have to ascend and descend stairs to get on the buses; putting turnstiles on the platforms so that people pay before they enter the bus, thus saving time in fare collection; and installing traffic signal systems that give priority to buses over most other traffic. Capacities can be increased by using larger buses; designing bus stops to allow for more

than one bus to stop at one time; and dedicating lanes to the buses. Buses can also be made more attractive by painting them distinctive colors; adding amenities such as free on-board WiFi; and having electronic signs at each stop notifying riders when the next bus will arrive based on GPS trackers in each bus. According to some researchers, bus-rapid transit lines with all of these features can move more than 40,000 people per hour, as many as a heavy-rail line and far more people than a light-rail line and at a far lower cost.[69]

The advantage of buses over trains was revealed at the 2014 Super Bowl, which took place in the Meadowlands in East Rutherford, New Jersey. Billed as the "transit Super Bowl" because severe parking limits required most spectators to arrive by mass transit, football fans were given a choice of arriving by New Jersey Transit trains or chartered buses. The buses worked great, smoothly moving people in and out of the stadium four buses at a time.[70] But the trains were overloaded, with some people having to wait as long as 90 minutes before getting to the stadium and others having to wait nearly three hours after the game ended before being able to leave.[71] If the 72,000 people who attended and staffed the 2015 Super Bowl in Phoenix all depended on light rail to arrive and depart, at 9,000 people per hour it would have taken eight hours to fill the stadium and eight hours to empty it out again.

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In designing transit systems, it is important to choose the right tool for the job. In lightly traveled areas, ordinary bus service can move hundreds of people per hour. In more heavily used corridors, bus-rapid transit using lanes shared with other vehicles and ordinary bus stops can move thousands of people per hour. Where demand is higher still, bus-rapid transit with special platform-level stations, pre-payment of fares before boarding, and larger buses can move well over 10,000 people per hour. Dedicating lanes to buses can increase this to as much as 40,000 people per hour. None of these cost as much as light rail, yet the capacity range is much greater than for light rail. What this means is that light rail is always the wrong tool for the job because there is no demand level that light rail can meet that buses can't meet for less money.

8 Bus-Rapid Transit Makes More Sense Than Rail

Some idea of the outlandish cost of light rail can be gained from the budget for the proposed comprehensive transportation plan. As referred to the city council by the Citizens Committee on the Future of Phoenix Transportation in February, 2015, the plan includes 17.7 miles of light rail, 31.5 miles of so-called high-capacity transit (either light rail or bus-rapid transit), and 67 miles of bus-rapid transit.[72] As shown in table 4, the cost differences between light rail and bus-rapid transit are huge: when measured per mile, light-rail capital costs are 140 times greater than bus-rapid transit, while light-rail operating costs are nearly six times greater.

Table 4 . Summary of Corridor Improvements in Phoenix Transportation Plan

MODE	MILES	CAPITAL COST	OPERATING COST	CAPITAL/ MILE	OPERATING/ MILE
		(dollars in millions)			
Light rail	17.7	$2,139	$897	$120.8	$50.7
High-capacity transit	31.5	$4,582	$923	$145.5	$29.3
Bus - rapid transit	67.0	$58	$577	$0.9	$8.6

Source: Citizens Committee on the Future of Phoenix Transit Meeting Packet for February 4, 2015, Exhibit A.

Note that the capital cost of the "high-capacity transit" lines is even greater than for light rail. Although federal law requires cities to not decide between rail and bus until they have completed an environmental impact statement, Phoenix has obviously budgeted for rail, not bus, in these so-called high-capacity transit corridors. Also note that the average capital cost for both light rail and high-capacity transit is much greater than the cost of Valley Metro's existing light-rail line. Considering the history of rail cost overruns, the final cost is likely to be much more than shown in table 4.

When measured per mile, light-rail capital costs are 140 times greater than bus-rapid transit, while light-rail operating costs are nearly six times greater.

Bus-rapid transit can be more expensive than shown in table 4, but as this comparison shows, it doesn't have to be. Bus-rapid transit lines with special lanes dedicated solely to transit are likely to be more expensive than the costs shown in table 4, though still less expensive than light rail. The problem with dedicating lanes to buses is that, like light rail, it is very expensive and used by only a few people. Los Angeles, for example, has some dedicated bus lanes on which it runs, during the busiest times of the day, just one bus every eight minutes. That means the lanes are 99.8 percent empty during rush hour, which is a waste if the goal is to reduce congestion.

Rail advocates sometimes argue that some potential transit riders will ride trains but not buses. In fact, transit ridership is more sensitive to frequencies than to whether the vehicles have rubber tires or steel wheels. As Department of Transportation Undersecretary Peter Rogoff said when he was the administrator of the Federal Transit Administration, "you can entice even diehard rail riders onto a bus, if you call it a 'special' bus and just paint it a different color than the rest of the fleet."[73] Buses that offer amenities such as free WiFi are likely to attract as many—if not more—new riders as trains.

In 2013, light-rail operations cost Valley Metro an average of $11.81 per vehicle revenue mile, or more than $35 per mile for a three-car train. By comparison, Valley Metro spent less than $9 per mile running buses, and transit agencies in Scottsdale and Tempe spent even less. That means Valley Metro could run buses as much as five times as frequently as it currently runs light rail at little or no extra operating cost, and the increased frequency would potentially attract more passengers than light rail carries. Over the course of a day, the average Valley Metro light-rail car holds 40 passengers, all of whom could easily fit on a bus.[74]

Nor would buses be significantly slower than light rail. Valley Metro light-rail trains crawl along between Phoenix and Tempe at an average of less than 18 miles per hour, taking 66 minutes to get from one end of the 19.6-mile route to the other.[75] Motor vehicles can make the same, or nearly the same, trip on streets in 44 minutes. A bus-rapid transit route with 26 intermediate stops of one minute each could make the same trip in 70 minutes.

Bus speeds could be increased by requiring that passengers pay before they board the bus, as they do for light rail. Bus-rapid transit systems in various South American cities use this system with enclosed stations at each stop that have turnstiles to control entry and exit. When buses arrive, people just step on and off. This reduces the time required for each stop to less than 20 seconds, meaning the entire trip would take less than an hour.[76]

Rail advocates argue that buses using shared lanes will be slowed by congestion while trains can avoid it. To the extent that is true, the appropriate solution is to take steps to relieve congestion for everyone, not for the 0.2 percent of travelers willing and able to take a train. Traffic signal coordination, couplets of one-way streets, and careful design of right- and left-turn lanes can all reduce congestion at a fairly low cost and do so far more effectively than trying to get a few people out of their cars and onto transit.

A critical advantage of buses over light rail is their flexibility. From the initiation of a bus plan to the inauguration of service can take well under a year,

compared with the decade required for Phoenix's light-rail line. Bus routes can change overnight as travel patterns change. If a bus breaks down, other buses can go around it, while if a light-rail car breaks down, numerous trainloads of riders can be delayed.

Rail advocates try to make a virtue of this defect in rail by claiming that developers are more likely to build where they know transit service will be "permanent." But this is absurd; if there is a market for transit service, there is no reason to believe it will go away. The reality is that, where buses can respond to changes in travel patterns, rail cannot, so rail transit agencies attempt to become land-use czars trying to force people to change their travel patterns to accommodate the transit system, rather than the other way around.

9 New Transportation Technologies Will Make Most Transit Obsolete

If big-box transit makes no sense in Phoenix when compared with medium-box transit in the form of 40-foot buses, it is likely that both big-box and medium-box transit will become mostly obsolete in the face of small-box transit in the form of shared, self-driven cars. Google, Nissan, Volkswagen, Bosch, and Continental are among the auto manufacturers, parts suppliers, and software makers that are developing self-driving cars. A 2014 survey of more than 200 experts found that most expect that cars that can drive themselves in most situations will be on the market by 2020.[77]

Uber, the car-sharing internet company, has recently hired 40 self-driving auto engineers away from Carnegie Mellon University with the goal of having its own fleet of self-driving cars that people can use in lieu of owning their own cars or hiring a driver.[78] Uber CEO Travis Kalanick predicts that, with self-driven cars, "the cost of taking an Uber anywhere becomes cheaper than owning a vehicle," which would also make it far less expensive than public transit.[79] Since self-driving cars are also expected to reduce congestion, this means that they are likely to replace transit everywhere except in places where population and job densities are too great for autos to work—which, in the United States, mainly means New York City.

It is likely that both big-box and medium-box transit will become mostly obsolete in the face of small-box transit in the form of shared, self-driven cars.

Whether by Uber or someone else, Kalanick's vision could be realized in less than a decade. This means it makes little sense for Phoenix or any other city to be planning expensive transit projects that often take a decade or more to complete and whose expected lifespan is another three decades.

Conclusions

Despite claims by rail advocates, an objective look at the Phoenix light-rail line that opened in late 2008 reveals that it is an expensive failure: it cost far more than was originally projected; it contributed to the reduction in transit ridership since the year it opened; and it has not produced the economic development benefits that are claimed for it. More light-rail lines will not solve the problem as Phoenix is simply not suited to the big-box transit systems represented by light rail.

The proposed "comprehensive transportation plan" is thus a misguided transit plan that is primarily focused on light-rail transit. Virtually all of the tax increase is needed solely for rail, as the revenues generated by the increase are approximately equal to the projected costs of the rail lines. If the rail projects suffer cost overruns, Valley Metro will almost certainly choose to forego some of the bus projects included in the plan rather than build less rail.

Such cost overruns are almost inevitable, as the vast majority of light-rail lines built since 1985 have cost more than originally projected. The original projected cost for the Phoenix light-rail line, for example, was $30 million per mile, while the final cost was more than $90 million per mile.

Despite rhetoric from the city, the proposed plan would not reduce congestion or improve environmental quality. In fact, under the plan Phoenix would have more traffic congestion, use more energy, and emit more greenhouse gases.

It appears that the main beneficiaries of Phoenix's transit plans are rail contractors and developers who enjoy subsidies for putting their developments near rail stations.

Buses would work better than rail on all planned light-rail and "high-capacity transit" routes, providing more-frequent and sometimes faster service at a lower cost and one that does not require a tax increase. With Phoenix's employment and land-use, buses are superior to rail in almost every way: they not only cost far less, they are more flexible and new bus routes can be planned and implemented in less than a year rather than the ten years that seems to be required for new rail lines.

Phoenix's grand plan for using rail transit and transit-oriented development is not likely to significantly reduce driving even if reducing were a desirable social goal, which it is not. Instead, by concentrating development, all it will do is increase congestion, with the wasted fuel and air pollution that is associated with that congestion.

Valley Metro's oft-repeated claim that light rail has stimulated $7 billion in new developments is simply untrue. Instead, the agency documented $7 billion in development *plans*, most of which had been made before the 2008 financial crash and many, if not most, of which were never completed. Many of those that were built received subsidies such as low-income housing tax credits. Without the subsidies, it is likely that even fewer of the projects would have been completed.

In general, claims that rail transit stimulates urban development are wrong. At most, it merely shifts where that development takes place, benefiting some property owners at the expense of others. At worst, the increased tax burden required to support rail transit will actually slow urban growth.

It appears that the main beneficiaries of Phoenix's transit plans are rail contractors and developers who enjoy subsidies for putting their developments near rail stations. Everyone else loses: transit riders would probably lose service due to rail cost overruns; auto drivers would face increased congestion; and taxpayers would pay more taxes to get an increasingly expensive and obsolete transportation system. •

Endnotes

1. Mary E. Peters, "Citizens Committee on the Future of Phoenix Transportation Recommendations," report to city council, March, 2014, exhibit A, "Comprehensive Phoenix Transportation Plan."
2. *2035 Regional Transportation Plan* (Phoenix: Maricopa Association of Governments, 2014), p. 7-11.
3. "Mesa Light Rail Expansion Plans Moving Forward," *Economic Reporter*, vol. 2, #3 (2009), tinyurl.com/ndpllh6, p. 1.
4. Katie Berk, "Phoenix's Valley Metro Sets Sights on Expansion—A Loss of State Funding Notwithstanding," *Progressive Railroading*, June, 2010, tinyurl.com/nhocx7b.
5. "Federal Transit Administration Officials Visit METRO Light Rail," Valley Metro, March, 28, 2011, tinyurl.com/pqtke57.
6. *Five-Year Strategic Plan, FY 2016–2020* (Phoenix: Valley Metro, 2015), tinyurl.com/ppql7wm, p. 4.
7. "Economic Development Highlights Brochure," Valley Metro, 2013, tinyurl.com/pmf6n9q, p. 2.
8. Gary Nelson, "Mesa Looks at More Low-Income Housing," *Arizona Republic*, April 26, 2014, tinyurl.com/pazv2og.
9. "Light Rail Economic Development Highlights," Valley Metro, Phoenix, 2009, p. 2, tinyurl.com/LREDH2009; "Light Rail Economic Development Highlights," Valley Metro, Phoenix, 2013, p. 3, tinyurl.com/LREDH2013.
10. *Adopted Budget, FY 14–15* (Portland: Portland Development Commission, 2014), p. 16.
11. *Gateway TOD Policy Plan* (Phoenix: City of Phoenix, 2015), tinyurl.com/qj2tujy, p. 189.
12. John Landis and Robert Cervero, "BART and Urban Development," *Access* 14 (Spring, 1999): p. 15.
13. Michael Bernick and Robert Cervero, *Transit Villages in the 21st Century* (New York: McGraw Hill, 1996).
14. Robert Cervero and Samuel Seskin, *An Evaluation of the Relationship Between Transit and Urban Form* (Washington, DC: Transportation Research Board, 1995), p. 3.
15. Randal O'Toole, *Debunking Portland: The City That Doesn't Work* (Washington: Cato Institute, 2007), pp. 5–6.
16. Randal O'Toole, *Do You Know the Way to L.A.?* (Washington: Cato Institute, 2007), pp. 18–19.
17. National Transit Database Historical Time Series (Washington: Federal Transit Administration, 2014), table TS3.1, Uses of Capital.
18. "Transit Excise Tax Revenue Bonds, Series 2004," City of Phoenix Civic Improvement Corporation, December 7, 2004, tinyurl.com/onuzov8, p. 8.
19. "Light Rail Schedule Updated to Reflect Project Changes," *Destinations*, Summer, 2004, tinyurl.com/qbu7ml9, p. 2.
20. "Light-Rail Construction: The End Is Near?" *Arizona Republic*, April 29, 2008.
21. The series of reports are: D. H. Pickrell, *Urban Rail Transit Projects: Forecast versus Actual Ridership and Cost* (Washington: U.S. Department of Transportation, 1990), p. xi; *Predicted and Actual Impacts of New Starts Projects–2003* (Washington: Federal Transit Administration, 2003), Table 2, tinyurl.com/mx4ea7d; *The Predicted and Actual Impacts of New Starts Projects–2007* (Washington: FTA, 2008), p. 11, tinyurl.com/8kpnyr; *Before and After Studies of New Starts Projects: Report to Congress* (Washington: Federal Transit Administration, 2011), tinyurl.com/nx99bpp; *Before and After Studies of New Starts Projects: Report to Congress* (Washington: FTA, 2013), tinyurl.com/lemb6fd. A summary table showing the results from all of these report can be found in Randal O'Toole, *Rails and Reauthorization* (Washington: Cato Institute, 2015), tinyurl.com/q9zvhyo, pp. 12–13.
22. *Historical Data Files, National Transit Database* (Washington: Federal Transit Administration, 2014), table TS2.1, "Service and Operating Expenses Time-Series by Mode."
23. Ibid.
24. "Public Transportation Ridership Report: Fourth Quarter & End-of-Year 2014," American Public Transportation Association, tinyurl.com/kwlfy3q, p. 10.
25. *2013 National Transit Database* (Washington: Federal Transit Administration, 2014), "Service" spreadsheet. Includes transit services provided by Glendale, Peoria, Scottsdale, Surprise, as well as Phoenix and Valley Metro.
26. *2013 Highway Statistics* (Washington: Federal Highway Administration, 2014), table HM-72.
27. *Summary of Travel Trends: 2009 National Household Travel Survey* (Washington: Federal Highway Administration, 2011), table 16.
28. Calculations based on urban travel shown in table VM-1 of *2013 Highway Statistics*, assuming 1.67 occupants per light vehicle, 1 per motorcycle and heavy truck and 12 per bus, result in an overall average occupancy of 1.67 people per vehicle, indicating that buses offset heavy trucks.
29. *2013 American Community Survey* (Washington: Census Bureau, 2014), table B08301 for urbanized areas.
30. Ibid for places.
31. *Journey to Work Trends in the United States 1960-2000* (Washington: Federal Highway Administration, 2003), p. 1-19.
32. *2013 American Community Survey*, table B08141 for urbanized areas.
33. Ibid.
34. Calculated from the *2013 National Transit Database*, "energy" and "service" spreadsheets.
35. *Transportation Energy Data Book, edition 33* (Oak Ridge, TN: Department of Energy, 2014), table 2.13. For gasoline-burning vehicles, each BTU represents 0.0713 grams of carbon dioxide emissions, as shown in "Carbon Dioxide Emission Coefficients," Department of Energy, tinyurl.com/loc3hvq.
36. Mikhail V. Chester and Arpad Horvath, "Environmental Assessment of Passenger Transportation Should Include Infrastructure and Supply Chains," *Environmental Research Letters* 4 (2009), tinyurl.com/njz4vt.
37. *Edge City: Life on the New Frontier* (New York, NY: Doubleday, 1991), p. 25.
38. Using 2010 census data, the correlation between the transit's share of commuting in an urban area and the number of downtown jobs in that area is 0.87, or nearly perfect, while the correlation between transit's share of commuting and the urban area's population density is only 0.46.

39. Wendell Cox, *United States Central Business Districts* (Belleville, IL: Demographia, 2014), pp. 4, 6.
40. Urban area densities calculated from "Changes in Urbanized Areas from 2000 to 2010" spreadsheet, Census Bureau, 2012, tinyurl.com/pydrjx9.
41. Ibid, pp. 6, 20.
42. "Encouraging Transit-Oriented Development: Case Studies That Work," City of Phoenix, tinyurl.com/naohvrq, p. 1.
43. Dowell Myers and Elizabeth Gearin, "Current Preferences and Future Demand for Denser Residential Environments," *Housing Policy Debate*, volume 12 (2001), no. 4, pp. 635–636.
44. "Millennials Won't Be Life-Long Renters," Pulte Group, Bloomfield Hills, MI, April 1, 2013, tinyurl.com/oh8zkax.
45. See, for example, Arthur Nelson, "Special Report: Housing's Future Is All About Demographics," Tucson Association of Realtors, 2015, tinyurl.com/ptxdyqx, p. 1.
46. Wendell Cox, "Dispersing Millennials," NewGeography.com, tinyurl.com/m5ozy5f.
47. "Millennials: Not Destined to Be Life-Long Renters," PulteGroup, tinyurl.com/oovkfby.
48. William L. White, Robert Bole, and Brett Sheehan, "Affordable Housing Cost Study: An Analysis of Housing Development Costs in Portland, Oregon," Housing Development Center, Portland, 1997, p. 1, tinyurl.com/mrkzgw5.
49. Samuel R. Staley, "Creating Livable Communities: The Limits and Potential of Transit-Oriented Development," testimony before the Senate Committee on Banking, Housing, and Urban Affairs, March 26, 2009, tinyurl.com/pfbac3z, pp. 1-2.
50. John Charles, "Comments on the Draft Plan Bay Area," May 13, 2013, tinyurl.com/pgql4gz, pp. 6, 10, 11, 30.
51. David Brownstone, "Key Relationships Between the Built Environment and VMT," Transportation Research Board, 2008, p. 7, tinyurl.com/y9mro58.
52. *Highway Statistics 2013* (Washington: Federal Highway Administration, 2014), table SF-1.
53. *Highway Statistics 2013*, table LFG-1; *Highway Statistics 2012*, table VM-3. (For some reason, the Federal Highway Administration has local government financial data for 2012 in the 2013 *Highway Statistics*.)
54. Rémy Prud'Homme, "Urban Transportation and Economic Development," keynote speech for the 7th conference on Development and Planning of Urban Transport in Developing Countries (CODAU VII), New Delhi, February 12, 1996, tinyurl.com/n9sh3a4, p. 1.
55. Unless otherwise noted, all costs in this section are from the 2013 National Transit Database, Service, Operating Cost, and Capital Cost spreadsheets.
56. "Transit Budget and System Overview," City of Phoenix, 2015, p. 17, tinyurl.com/pznqtbq.
57. Federal Transit Administration, *National State of Good Repair Assessment* Washington, 2010), p. 3, http://www.fta.dot.gov/documents/National_SGR_Study_072010(2).pdf.
58. Oregon Secretary of State, *TriMet: General Management Review and Issues Deserving Additional Attention*, Salem, 2014, p. 41.
59. Joseph Rose, "TriMet Tweets: Sorry for the (Many) MAX Breakdowns, Portland (And Here We Go Again)," *The Oregonian*, May 15, 2014, tinyurl.com/nqcutmo.
60. Thomas A. Rubin and Fatma Mansour, *Transit Utilization and Traffic Congestion: Is There a Connection?* (Los Angeles: Reason Foundation, 2013), p. EX-1.
61. John Semmens, "Does Light Rail Worsen Congestion and Air Quality?" *The Freeman*, June 1, 2005, tinyurl.com/p52ndxq.
62. *Anaheim Rapid Connection Fixed Guideway Alternatives Analysis Report Draft* (Orange, CA: Orange County Transportation Authority, 2012), tables 3.10 and 3.13.
63. Laurie Blake, "Light Rail Will Always Slow the Flow," *Minneapolis Star-Tribune*, December 12, 2004.
64. *Purple Line Traffic Analysis Technical Report* (Baltimore: Maryland Department of Transportation, 2008), pp. 4-1–4-2.
65. *Red Line Final Environmental Impact Statement* (Baltimore: Maryland Department of Transportation, 2012), p. 5-125.
66. *Glossary or Transit Terminology* (Washington: American Public Transit Association, 1994), p. 23.
67. Robert L. Bertini,"Bus Facility Capacity," Portland State University, May 2, 2006, tinyurl.com/pn3cvu2, p. 3.
68. Ibid, p. 5.
69. *Better Rapid Transit for Greater Boston* (Boston: Greater Boston BRT Study Group, 2015), p. 17.
70. Joseph R. Vena, "Super Bowl 2014 Transit: Bus Riders Avoid Mob Scene That Train Riders Faced," *NJ.com*, tinyurl.com/lsf3p9n.
71. Jon Benne, "2014 Super Bowl: Large Crowds Cause Problems Getting to MetLife Stadium," *SBNation.com*, tinyurl.com/ovn8jg5.
72. Citizens Committee on the Future of Phoenix Transit Meeting Packet for February 4, 2015, Exhibit A. The citizens committee or city council may have made some minor changes to this plan, but the basic cost estimates should remain about the same.
73. Peter Rogoff, speech at the "National Summit on the Future of Transit," Boston, May 18, 2010.
74. *2013 National Transit Database*, "Operating Expenses" and "Service" spreadsheets. Average railcar occupancies are calculated by dividing passenger miles by vehicle revenue miles.
75. Valley Metro Rail Schedule, accessed July 2, 2015, tinyurl.com/VMRail.
76. Joseph Goodman, Milissa Laube, and Judith Schwenk, "Curitiba Bus System Is Model for Rapid Transit," *REImagine*, Spring, 2007, tinyurl.com/of9po7m.
77. Steven E. Underwood, "Automated Vehicles Forecast," University of Michigan, 2014, pp. 24, 26, 31, tinyurl.com/q8jhrva.
78. Mike Ramsey and Douglas MacMillan, "Carnegie Mellon Reels After Urber Lures Away Researchers," *Wall Street Journal*, May 31, 2015, tinyurl.com/nefd2bg.
79. Casey Newton, "Uber Will Eventually Replace All Its Drivers With Self-Driving Cars," *The Verge*, May 28, 2014, tinyurl.com/qdyvroo.