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Executive Summary

Background

This study evaluates the benefits and costs of the proposed $3.9 billion transit system that residents in the Puget Sound region will vote on in November 1996. The study was sponsored by the Washington Research Council—a non-profit, non-partisan, research institute. The analysis was conducted by ECONorthwest, an economic consulting firm that specializes in the application of benefit-cost analysis to multi-modal transportation investment decisions.

Results of Analysis

The RTA system plan is not a cost-effective investment based on this report's evaluation of the likely changes in transportation performance. Our analysis indicates that the costs of the RTA plan exceed its transportation benefits by $2.5 billion. The annualized cost per new transit rider is $13,028 and the return on the public's investment is minus 4.2% per year. Using the RTA's assumptions of the benefits, the plan's costs still exceed its benefits by nearly $1 billion. In all of our analysis, we use the RTA's assumptions about the cost of building and operating the proposed transit system.

Evaluation of Transportation Benefits and Costs of the RTA over Thirty Years

	ECONorthwest Assumptions	*RTA Assumptions*
Benefits Minus Costs (billions)	($2.5)	($1.0)
Rate of Return	(4.2%)	1.1%
Annualized Cost per New Transit Rider	$13,028	$9,314
Assumptions	2010 benefits as estimated by RTA and ECONorthwest. Discount rate: 4%; Benefit growth rate: 0%; Maintenance cost growth rate: 1%; RTA's stated estimates of capital and operating costs;	

The analysis tested the degree to which changing key assumptions varies the result. The value of time and a benefit multiplier used to account for potential changes in the RTA's performance relative to the base case had the largest effect. Within a reasonable range of these values no one parameter changed the net benefits of the RTA plan by more than 16% of our point estimate of minus $2.5 billion.

As a transportation improvement the RTA plan doesn't meet basic investment criteria of having benefits which exceed its costs. Our report considered other potential effects of the plan such as improvements in land-use and air quality and found the RTAis not likely to generate measureable benefits in these areas. There are some non-transportation benefits which may lead voters to support the measure anyway. Investments in rail are popular in other cities even when they provide limited transportation benefits. It appears that other areas like the image rail projects about a region's willingness to provide alternatives to the automobile even though relatively few people actually use it. Rail systems also convey an image about being a "big league" city that may help in the marketing of a region. The voters must decide whether these non-transportation benefits are worth the cost of the RTA.

Review

This analysis was conducted by ECONorthwest, an economic consulting firm that has done numerous projects for the state and federal government on the application of benefit-cost analyis to transportation investments and policies. The report was written by Daniel Malarkey; Terry Moore, David Reinke and Randy Pozdena reviewed early drafts and suggested many useful revisions.

Early versions of the report were given to the RTA staff for their comments and any corrections. While the RTA staff do not endorse this paper's conclusions, they have had an opportunity to raise issues and pose questions to better reflect the work they did putting together the current plan. This study was also reviewed by a panel of outside transportation experts. They include:

Paul Courant, Chair, Economics Department, University of Michigan

Jose Gomez-Ibanez, Derek Bok Professor of Urban Policy and Planning, Graduate School of Design and John F. Kennedy School of Government, Harvard University

John Kain, Visiting Professor, University of Texas at Dallas and Henry Lee Professor of Economics and Professor of Afro-American Studies, Harvard University

Steve Fitzroy, Consultant and Former Director of Research and Forecasting for the Puget Sound Regional Council

Anthony Rufolo, Professor of Urban Studies and Planning, Portland State University

These reviewers have signed on to the following statement:

"We have reviewed the analysis conducted by ECONorthwest of the Regional Transit Authority's proposed system plan. The methods and assumptions used in this analysis are consistent with those that professional transportation economists would use in analyzing projects of this type. The estimates of the range of net transportation benefits of the plan are reasonable and provide useful information for voters to consider when deciding whether to support the measure."

1. INTRODUCTION

The Puget Sound Region is considering a major investment of public funds into transportation

Voters in the urbanized areas of Puget Sound must decide this November whether the region should buy an enhanced regional transit system. The Regional Transit Authority is proposing new bus lines, improved access to HOV lanes, commuter rail, and light rail to connect different parts of the region. Puget Sound residents will pay for these improvements with an increase in the sales tax (four tenths of one percent) and an increase in the motor vehicle excise tax (three tenths of one percent). The plan will cost the average household $121 per year for the next ten years.[1] The total cost is $3.9 billion over the next ten years and will require further ongoing operating subsidies, debt service payments, and capital replacement after then.

How should the region evaluate that transportation investment?

Is the RTA plan a good transportation investment? This report provides information to help voters make that evaluation. Our approach attempts to answer the questions often posed by households when they make a substantial transportation purchase decision such as deciding to buy a particular car:

- What will it cost to purchase?
- What will it cost to operate?
- How much will we actually use it?
- Can we afford it on our current budget?
- Are there other alternatives that provide the same level of service but cost less?

Transit investments, like automobiles, do more than just provide transportation. They also convey an image and make a statement about style and priorities. These features sometimes dominate the decisions about the type and cost of a car someone buys. The decision to buy a car also affects the economic well-being of businesses such as the local service station. While these effects rarely weigh into an individual's purchase decision, they represent real consequences of the decision to buy a car. Our analysis of the RTA proposal considers both the transportation and non-transportation benefits of the proposed plan, including its potential economic effects.

[1] Washington Research Council, *Policy Brief*, September 1996.

Since we are trying to describe and evaluate the benefits and costs of alternative transportation investments, our evaluation is based on the principles of benefit-cost analysis. Most economists advocate this approach, but non-economists sometimes criticize it, mainly for the following reasons:

1. The analysis can miss some important categories of benefits or costs such as environmental costs.
2. Analysts don't know enough to predict the effects of some policies or the potential effects are so uncertain as to make benefit-cost analysis a pointless exercise.
3. The whole framework is invalid because there are some things to which one cannot assign dollar values.

In this study we have been careful to avoid the first criticism by developing an exhaustive list of the potential benefits and costs. We have been aided in this by the RTA staff, who have developed a comprehensive list of the plan's benefits. While we have not succeeded in calculating dollar values for all these benefits, we have a complete list to work from. Regarding the second point, we have tried to acknowledge uncertainty where it exists and to test a range of reasonable assumptions. If the likely effects of the RTA plan are uncertain, then that is something voters should consider. In the private sector, when the potential returns of an investment are uncertain or risky, then investors usually require a higher rate of return to account for this risk. In our analysis we acknowledge the uncertainties that exist and try to consider a range of reasonable values.

Regarding the last point, we agree that it is not possible to assign dollar value to everything and some important aspects of life fall outside the calculus of dollars and cents. Nonetheless, given the magnitude of the proposed investment, we think voters deserve the best estimate possible of the dollar value of costs and benefits we can calculate given the information and analytic tools that are available. Voters can then compare the range of estimates for the measurable benefits and costs to the intangible benefits and costs (the ones that can be described, but perhaps not monetized or even quantified) to make a decision about whether, in their judgment, the investment is worth making.

Background on this Report

This study is a companion study to a July 8, 1996 Special Report released by the Washington Research Council entitled, *Regional Transit Again: A Look at the New Plan*. Readers interested in an overview of the current plan and its history should consult that document as well as the RTA's *Ten-Year Regional Transit System Plan*.

The analysis was conducted by ECONorthwest, an economic consulting firm. ECONorthwest has 20 years of experience advising public and private clients on all aspects of the development, operation, and financing of public facilities and services including: siting, least-cost planning, benefit-cost analysis, financing, forecasting and modeling, cost-of-service analysis, rate-setting, and policy analysis. ECO has offices in Seattle, Portland and Eugene and has a staff of twenty-five professional economists, planners, and policy analysts.

In recent years ECO has conducted a number of studies for the Federal Highway Administration, the Washington State Department of Transportation, and the Puget Sound Regional Council on the application of *least-cost planning* to transportation system planning. ECO's work has shown how to apply benefit-cost analysis to compare a wide range of alternative transportation policies and investments.

How this report is organized

This paper follows the basic steps in benefit-costs analysis.

Chapter 2, Evaluation Framework, describes the principles one should use in any rigorous evaluation of public policy and investment decisions. It provides an overview of the principles of benefit-cost analysis and highlights some of the potential pitfalls.

Chapter 3, Costs, estimates the costs of building and operating the system. It reviews the capital and operating cost estimates used by the RTA plan and compares them to similar costs in other regions. It also discusses likely future trends in operating costs.

Chapter 4, Transportation Benefits, reviews the RTA's estimates of the annual benefits of the investment and describes the categories of benefits we have re-estimated to reflect standard practice in this type of analysis.

Chapter 5, Transportation Benefits and Costs Over Time, evaluates the value today of the likely stream of benefits and costs from the RTA plan using our revised estimate of the benefits and the RTA's estimate of the annual benefits. This chapter also identifies some of the cost-effective elements of the plan.

Chapter 6, Other Benefits, discusses some of the other non-transportation benefits that the RTA plan could provide the region.

The final chapter offers some thoughts for voters to consider on the uses of benefit-cost analysis.

2. EVALUATION FRAMEWORK

This chapter describes the principles we used in our analysis of the benefits and costs of the RTA proposal. Without an understanding of the fundamental concepts and methodological issues associated with benefit-cost analysis, readers may have difficulty following our analysis. The following principles guide our review and revision of the benefits claimed by the RTA and our evaluation of the project's net benefits.

At one level the task is quite simple. We need simply put dollar values on all the costs and benefits of the system, such as those listed in Table 1 and any others that are relevant. Once we know the total costs and benefits and account for how they occur over time we can see whether the benefits exceed the costs. But there are a number of issues to that analysts must consider.

Table 1. Categories of Costs and Benefits of the RTA Proposal

Costs	Benefits
Capital	Travel time savings for system users
Operating	Parking cost savings
Increased delay due to construction	Auto ownership and operating cost savings
	Travel time savings for drivers on roadways
	Improvements in transit system reliability
	Transportation benefits for special events
	Increased commercial activity:
	Air quality and health benefits
	Improved urban form, reduction of sprawl
	Integrating fare systems

2.1. Measure changes in performance and system costs

The main reason for making some investment in a transportation system should be to improve the performance of the system over what it would be in the absence of that investment. Typical measures of transportation performance are travel time (a measure of the amount of congestion), operating cost, and safety. Analysts need to know how the transportation system will perform with the investment compared to how it will perform without the investment. This first step also includes measuring the direct costs of those improvements: planning, design, construction, operation, and maintenance (which includes costs to both users and institutions).

2.2. Evaluate *all* significant benefits and costs

Many of the costs of transportation projects can be measured by adding up the market costs of the resources those projects use. Freeways take labor (planning, design, construction), concrete, steel, machinery, and so on. The costs can be added and expressed in dollars. Many of the benefits and costs of public projects, however, are ones not typically registered through market transactions. Some of these benefits and costs are not internalized in the prices paid for the goods and services needed to build and operate the project—for example, the costs of air pollution on people and property near highways where automobiles generate that pollution. Economists call such costs spillovers or externalities, and argue that society should consider them in its evaluation of a project since they result in real gains or losses.

An example makes the point clear. Suppose a city is evaluating two options for adding travel capacity across a river: one that adds new highway lanes to the existing bridge, and one that adds lanes for non-auto modes only (bus, bike, and pedestrian). Assume the costs and benefits are identical in both cases except that (1) the average travel time improvements are only slightly greater for the auto-oriented improvement, and (2) air quality is substantially worse with the auto-oriented improvement. If the decision is based only on user benefits and costs, one chooses the auto-oriented alternative. When the air-quality benefits of the second alternative are considered, however, the decision could be for the non-auto alternative.

An extensive literature exists in policy analysis in general, and in transportation in particular, on issues relating to identifying and valuing benefits and costs. The following is a summary of the main issues:

- *Costs are real economic resources used by a policy or project.* Money facilitates the exchange of useful resources, but is not a resource itself. Steel, concrete, labor, driver time, and gasoline *are* real resources that get used up in the process of trip-making. Concrete laid in a freeway is concrete not available for a sidewalk, and vice versa. Economists express this point by referring to *opportunity cost:* the value of a resource in its next best use (if it hadn't been used for what it was, in fact, used for). Most goods in a market economy sell at their opportunity cost—thus market costs can be used to measure the value of many benefits and costs. The cost of goods purchased from subsidized markets (e.g., goods purchased from the public sector) may need to be corrected to account for the true economic cost. Costs should be counted only when resources are used.

  This point has some important implications. It is not uncommon, for example, for evaluations of transportation projects to count costs as benefits, and sometimes more than once. To build a transportation project, one must use labor. It is a cost. But evaluations often count it as a benefit (income to the economy), then double or triple it (the multiplier effect), and then count it as a benefit yet again under the heading of *jobs.* A related point is that what are often listed and added as either benefits and costs are really *transfers.* Taxes and grants are usually transfers (see the note following on *perspective*): money may move from one place to another, but no resources are used.

- *Benefits are negative costs; costs are negative benefits.* Many of the benefits of transportation improvements are best expressed as reductions in the costs that would have been incurred in the absence of the improvement; for example, decreased travel time, accidents, and operating cost. The convention in the transportation literature, and the one followed in this project, is to talk about these decreases as *user benefits*, even though it is certainly true that for some users some of these factors may increase (e.g., an increase in travel time is a negative benefit). The convention derives from the reasonable assumption that for any transportation improvement to merit consideration, it should reduce these costs; the reductions in costs are benefits for the users.

- *Benefits and costs should be defined, to the extent possible, in a way that is both comprehensive and mutually exclusive.* Accounting for all benefits and costs requires identifying a comprehensive list of all (or at least the significant) benefits and costs. But, the categories should not overlap, or else some will be counted twice. For example, transportation evaluation typically counts reductions in travel time as a benefit. But many evaluations go on to count as benefits increases in property values and tax revenues due to such reductions in travel time, thereby double- and triple-counting the benefit.
- *Measuring all benefits and costs means considering some that do not have obvious market prices.* The most obvious example is loss of environmental quality from pollution. Less obvious is the loss of time because of congestion. Though air quality and travel time are not traded in any established market, they still are real costs that must be considered in any full evaluation of the costs of transportation investments. The professional literature of transportation and environmental economics provides a range of accepted values for the value (in dollars) of these types of costts.

2.3. Discount to Present Value

Assume that all costs and benefits have been identified, categorized properly to reduce double-counts and transfers, quantified, and monetized. It is not enough to simply add them up. Benefits and costs that occur at some time in the future are worth less to most people than are the same benefits and costs occurring today. Benefit-cost analysis accounts for this preference for present consumption.

Given the choice of $100 today or a note redeemable for $100 one year from now, most people would choose the $100 today. But if that note were worth $1000 in one year, most people would choose the note over the immediate $100: they would accept the postponement of gratification, the erosion of inflation, and the risk that, for whatever reasons, that payment in a year will end up being less than $1000. At some point in between they would be indifferent. In other words, individuals discount future dollars: a dollar next year is worth less than a dollar today, even if there were no inflation. Likewise, society as a whole is indifferent to receiving a dollar's worth of benefits in the future or some lesser amount today. This lesser, discounted amount is called the present value of the future benefit.

The discount rate should reflect the opportunity cost of alternative uses of the money. Most often the opportunity cost of capital is viewed as the real rate of return on investments in the private sector. While the basic notion of opportunity cost is straightforward, the theory for selecting the appropriate discount rate gets complicated. Most economists who do research on discount rates recommend real—i.e. ignoring inflation—discount rates between 2% and 7%.

2.4. Focus on Differences Between Alternatives

Project evaluation can be simplified by comparing each project to a "reference", or "do-nothing" alternative. To choose among alternative actions, it is sufficient to know how their effects differ. In all cases the concern should be with reasonable estimates of the *additional (marginal) costs and benefits* resulting from a proposed action, compared to doing nothing.

2.5. Perspective: Benefits and Costs from Whose Point of View?

Not only must all effects be considered, but they should also be considered from all important perspectives. For example, a grant from the federal government to regional agency is an expenditure for the U.S., a revenue for the region the agency serves, and a transfer from the perspective of net social (national) cost. The issues of transfers cannot be ignored if governments are to make efficient investments in transportation. Local governments often consider earmarked federal funds as benefits, or at least ignore them as costs. Projects with 80% federal funding will usually look good to local governments: they are, after all, receiving real resources that they can use to their benefit. But the federal government is also right to hold local governments to a more restrictive standard when it hands out discretionary funds. From the national perspective, giving funds to one local government has real opportunity costs because those funds are not available for another project elsewhere. The concern should be primarily for the efficiency of projects based on total resource costs.

2.6. Alternative Selection and Project Evaluation

Benefit-cost analysis is often used to compare alternative investments: Should we invest in a regional plan that emphasizes buses or one that relies on rail transit? In our papers on integrated transportation planning (ECONorthwest, 1995a, 1995b, and 1995c), we have described the ways that planners can use benefit-cost analysis to develop and evaluate alternative transportation plans. Our task in this report is somewhat different: to answer the question of whether the RTA is a good transportation investment. In the course of analyzing the RTA plan, we have identified those elements that are more or less cost-effective; but we are not comparing the RTA to any other system alternative. The question we attempt to answer is similar to the one faced by the voters: Given the data available will we be better off with the RTA plan than without it?

To answer this question, we first consider the costs of the proposed system before turning to its benefits.

3. COSTS

The capital and operating costs of the RTA are approximately $4 billion[2] over the next ten years. This is a significant commitment of public resources to the regional transportation system. The following table shows how much all public agencies (federal, state, and local) spent on transportation in the Puget Sound region in 1992. The RTA plan represents approximately the equivalent of three years of the total public spending on transportation by all levels government. Assuming the RTA's annual spending is $400 million per year ($4 billion divided by ten years), the plan represents a 27% increase over the amount of public money spent on transportation in the region in 1992 using constant 1995 dollars.

Table 2. Uses of Transportation Funds in the Puget Sound Region

Uses	*Total 1992 Expenditures (millions)*	*Percent*
Public Transit	$395	29%
Highways	$328	24%
City Streets	$264	20%
County Roads	$256	19%
Ferries	$111	8%
Total	$1,354	100%

Source: Financial Element of Metropolitan Transportation Plan, 1995, Puget Sound Regional Council, Exhibit 2-2

Just because $4 billion is a significant increase in the public resources devoted to transportation does not mean the region should not spend it on the RTA plan. The point is that the plan represents a significant commitment of regional resources and should be carefully evaluated for the benefits it will provide.

Table 3 shows how the money will be spent over the next ten years. Approximately half will go to electric light rail, a sixth to commuter rail, a sixth to improved bus service and transit access to the HOV system, and the final sixth to community connections (stations, transit centers, and park-and-ride lots), administration, future planning, and contingencies. The ten-year period covered in Table 3 encompasses the full construction periods for the proposed rail elements and other capital investments. The operating costs are just for those elements that are completed and operating during the ten-year period.

[2] The RTA's figure is $3.9 billion in 1995 dollars. Converting 1995 dollars into 1996 dollars puts the total over $4 billion.

Table 3 includes $171 million in debt service. The RTA intends to finance $1 billion of the capital costs with thirty-year bonds. The debt service on that borrowing is $171 million through the year 2007. The total borrowing costs on the $1 billion is approximately $2.7 billion over thirty years, so the vast majority of the debt service will be paid after the period reflected in Table 3. By approving the plan, the region is committing itself to principal and interest payments on bonds through 2030 as well as the ongoing maintenance and operating expenses of the system.

Table 3. Total Ten Year Costs (1997 to 2007) of the RTA Plan
(in millions of 1995 dollars)

Expenditures	*Capital*	*Operating*	*Total*	*% of Total*
Electric Light Rail	$1,746	55	$1,801	46%
Commuter Rail	539	130	669	17%
HOV Access	377	0	377	10%
Regional Express Bus	92	269	361	9%
Community Connections	255	0	255	7%
Fare Integration	0	45	45	1%
Research & Technology	30	0	30	1%
Phase II Planning	30	0	30	1%
Contingency & Reserves		120	120	3%
Debt Service		171	171	4%
Administration		55	55	1%
Total	$3,069	$ 845	$3,914	100%

Source: RTA, *Appendix A*, p. A-2.

The capital and operating costs for the RTA have undergone extensive review by the RTA's Expert Review Panel. This panel has stated that these estimates are "a sound basis for decision making" and they are the best estimates we currently have about the project's total costs. In the analysis that follows we have relied upon the RTA's cost information. The RTA staff contend that the cost estimates are conservative and overstate the probable costs of their proposal. Our brief evaluation of some of these costs indicate that, while the capital cost estimates appear to be conservative, the operating costs are on the low end of the range experienced by other transit operators. Nonetheless, we use the costs recommended by the Expert Review Panel in our analysis.

3.1. Capital Costs

To double-check the capital costs we did a quick comparison of the per-mile costs of the light rail element of the RTA plan with the current estimate of the costs of the MAX Westside light rail line in Portland. The per-mile costs for the RTA are $83 million while MAX's are $52 million. The RTA line must be built through a much more urbanized area with higher land values and involves twice the amount of tunneling as for the MAX Westside line. Thus, one would expect Seattle's construction costs to be significantly higher than MAX's. Although we did not conduct a detailed evaluation of the capital costs in the RTA proposal, we did not find any evidence that the cost estimates are too low, as has been the case with rail projects in other U.S. cities.

Table 4. Comparison of RTA and Portland MAX Capital Costs

	RTA	*Portland Westside MAX line*
Capital Cost Estimate	$1.7 billion	$0.9 billion
Total Miles	21	18
Total Capital Costs Per Mile	$83 million	$52 million
Miles of New Tunnel	7	3

Source: RTA, *Appendix A*; Conversation with Sandy Bradley at TriMet, Westside Light Rail Project

3.2. Operating Costs

Table 5 shows the per-rider operating costs for light rail, bus, and commuter rail systems around the United States. The final row shows the RTA's estimates of these costs. The RTA's per-rider operating costs for light rail are significantly less than the average of agencies serving metropolitan areas of comparable size to the Puget Sound region. The RTA staff justify these lower operating costs because they assume that the RTA lines would be serving corridors with heavy transit ridership and that they will be able to operate at very efficient levels.[3] The RTA's per-rider bus and commuter rail operating costs are very close to national averages. However, the RTA's figures are below the existing per-rider operations and maintenance costs for the King County Metro bus system. The RTA justifies its operating cost estimates for bus transit with the explanation that the RTA will serve express routes with more demand and therefore more fare revenue than some of the routes that Metro currently services. However, the RTA plan also contemplates regular bus service during non-peak periods which will presumably be more expensive per boarding than Metro's current peak-period service. Also the regional service that RTA will provide is more typical of the kind of service provided by Community Transit which has the highest

[3] Personal communication with Bob Harvey, RTA staff.

cost per boarding because of the long trip length from Snohomish County into employment centers in King County.

As with the capital costs, we accept the judgment of the Expert Review Panel that the RTA's estimates are reasonable. However, in contrast to the capital costs, we have identified some reasons to believe that some of the operating costs (particularly for light rail) may be low.

The RTA's operating costs are estimated as if the system were running today. One of the important issues in analyzing the overall benefits and costs of the RTA proposal is the likely trend in these operating costs over the life of the system. Just as a car buyer wants to know the mileage and likely repair costs of a car when making a purchase, the trend in future operating cost is a major concern for transit systems.

According to data collected by the Federal Transit Administration, between 1990 and 1994 the national average operating costs per passenger mile increased by 4.0% per year for bus and 7.2% for light rail *after* inflation. A number of factors contribute to the increased operating costs per passenger mile: chief among them is the cost of labor. The wages of transit operators have significantly outpaced inflation and these costs have tended to drive up operating costs. Other factors such as increased congestion and moving service into less productive routes may have also driven up operating costs per passenger mile for buses. For light rail the recent addition of some more costly systems could also be contributing to increases in the national average. These trends toward higher operating costs have been underway for at least the last fifteen years. The National Transit Database shows that bus operating expenses per passenger mile (expressed in constant dollars) have been increasing at an annual rate of at least 4% for the last fifteen years.

William Baumol (1985) at Princeton first advanced the theory that the cost of providing public sector services will tend to increase more rapidly than other sectors of the economy. He theorized that the high percent of labor involved in delivering public services and the lack of opportunities for technical innovation to improve labor productivity in these sectors would create cost increases in government that exceed the rest of the economy. The experience of national transit operators confirms the tendency for the costs of particular public service like transit operations to increase at a rate faster than the overall price level.

Table 5. 1994 Operating Cost per Boarding for U.S. Transit in Regions Over 250,000 in Population

Transit Operator	*Light Rail*	*Bus*	*Commuter Rail*
Boston- MBTA	$0.88	$2.15	$4.30
Buffalo- NFTA	$1.65	$2.24	
Community Transit (Snoh.)		$5.55	
Denver- RTD	$3.81	$2.11	
Everett Transit		$3.16	
King County- Metro		$3.15	
Los Angeles- LACMTA	$3.71	$1.67	
Maryland MTA	$2.80	$1.54	$6.42
Memphis- MATA	$2.61	$1.78	
New Jersey- NJ Transit	$1.58	$3.02	$7.10
Pierce Transit		$2.63	
Portland- Tri-Met	$1.70	$1.84	
Sacramento RTD	$2.22	$2.34	
San Diego- The Trolley	$1.30		
San Francisco- Muni	$1.67	$1.24	
Santa Clara- SCCTD	$3.45	$3.27	
St. Louis- Bi-State	$1.44	$2.23	
Washington, DC- WMATA		$2.00	
Median	*$1.70*	*$2.23*	*$6.42*
Average	*$2.22*	*$2.47*	*$5.94*
RTA Projection	**$1.17**	**$2.56**	**$4.93 to $6.78**

Source: 1994 National Transit Database; RTA, Table 17 of *Appendix C*

Our analysis later considers a range of probable growth rates in the operations and maintenance costs for the proposed transit system. While we test the assumption of 0% growth in operating costs, given the experience of transit operators over the last twenty years, we think the most likely case is that operating costs will increase at rate somewhat greater than inflation over the next thirty years.

3.3. Delay Costs During Construction

It requires concrete, steel, and construction workers to build a new transit system; it also requires people to sit in their vehicles as they wait for the construction workers to move the concrete and steel into place. The costs of delay during construction are real costs that should be considered in the analysis of any major transportation investment. If the purpose of the RTA is to save people time who are now stuck in traffic and if those future time savings are to be counted as benefits (as they should be), then the more immediate time losses must similarly be counted as costs.

The Environmental Impact Statement for the RTA plan does not provide any detail on the amount of delay other than to acknowledge that such delay will occur. We have not estimated this delay cost for our analysis either. But residents of the region should recognize that construction delay is a real cost. If it is not included in the analysis, the true cost of building the system will be understated. And because it occurs early on it outweighs benefits of similar magnitude that occur later on.

3.4. Capital Depreciation

Eventually, light rail cars, commuter trains and the tracks they run on wear out and need to be replaced. For the system to keep delivering its transportation benefits, it must be kept in shape. These capital replacement costs will occur after the ten-year period of the current tax proposal but nonetheless represent real costs to the system. From 2007 to 2030, the RTA staff estimate the RTA will need to spend $511 million on capital replacement to keep its systems operating properly. This money is in addition to the annual operating and maintenance expenses.

At the end of thirty years the RTA will still retain the assets of the system which fall on the benefits side of the ledger. By the year 2030, the remaining value of the capital assets of the system will be approximately $1.4 billion dollars after considering depreciation and the money invested in capital replacement.

4. Transportation Benefits

The RTA has produced a summary of the benefits of their proposed transit system entitled *Appendix C: Benefits, system use and transportation impacts of Sound Move*. This report lists the major benefits of the RTA proposal and estimates the dollar value of the key transportation benefits. In this section we review the RTA's estimates and present our own analysis of the dollar value of these benefits for the year 2010. In our study we have reorganized the RTA's categories to address all the transportation benefits first. Table 6 lists the categories of benefits developed by the RTA, the RTA mid-point estimate of the benefits, and our revised estimate of the benefits.

Table 6. Estimates of RTA Plan's Transportation Benefits in 2010 Developed by the RTA and ECONorthwest

Types of Benefits	RTA Mid-range Estimates ($M/yr)	ECO Northwest Estimates ($M/yr)
Travel time savings for system users	98	65.6
Parking cost savings for system users	13	14.2
Reduction in vehicle miles traveled (auto operating/ownership cost savings)	19	24.2
Travel time savings for drivers of private vehicles	86	7.8
Reduction in required employer-provided parking	14	11.1
Increased mobility for commercial vehicles	13	0
Improvements in transit system reliability	7	6
Increased rail freight mobility	n.q.	n.q.
Transportation benefits for special events at Kingdome and baseball stadium	n.q.	2.3
Safety benefits of direct access to center HOV lanes	n.q.	n.q.
Improve road system reliability	n.q.	Unlikely
New People Moving Capacity	n.q.	Double Count
Preservation of Transit Travel Times Through Dedicated Right-of-way	n.q.	Double Count
Improving Transit Mobility for "Choice" and "Dependent" Riders	n.q.	Double Count
Total Quantified Benefits	**250**	**132**

n.q.: not quantified

Source: RTA, *Appendix C*, Table 8; ECONorthwest calculations. The RTA staff have changed their estimate of the project's net benefits since the publication of *Appendix C*. Earlier this summer the staff recalculated their estimate of the travel time savings to private vehicles and increased it from $20 million to $86 million. In response to an early draft of this report they no longer count a $25 million benefit associated with the reinvestment of local bus service that they previously claimed.

The RTA has not done the level of analysis on the current plan that was conducted on their earlier proposals. Due to reductions in funding the RTA has had to use the earlier modeling efforts to estimate the performance of the proposed system even though the current configuration is somewhat different. In the process of reviewing these extrapolations we identified some that seem reasonable while others were not. For each category of benefits we describe how the RTA estimated the value and our reasons for revising it.

4.1. Travel Time Savings for Transit Users

The main benefit of a transit investment is that it takes people who use the new transit capacity less time to travel than if the investment were not made. The RTA reports the following travel time savings for the proposed plan:

Table 7. Claimed time savings from RTA plan

	Carpools and Vanpools	*Bus Riders*	*Rail Riders*	*Total*
Daily Time Savings (minutes)	380,000	350,000	1,050,000	1,780,000
Annual Time Savings (millions of hours)	1.6	1.5	5.1	8.2
Annual Value of Savings (millions of 1995 $)	$19.2	$18.0	$61.2	$98.4
Implied Time Savings per Transit Boarding	n.a.	5.7 min	8.5 min	n.a.

Source: RTA *Appendix C,* Tables 3 and 4

The RTA indicated two sources for these estimates: one produced by WSDOT (1996) and the other by RTA (1993). We doubled-checked the reported time savings in these studies for the elements include in the RTA plan and found them to be roughly consistent. The RTA study entitled *Central Corridor Justification Project* was a study done for the federal government that analyzed a system similar to the current proposal minus the extension from the Boeing Access Road to SeaTac. It also did not consider any of the potential effects of the increased bus service in the transit in the current RTA plan on rail performance. The corridor study shows annual time savings of 4.1 million hours while the table above shows 5.1 million hours. The RTA staff indicated that the difference is due to the estimated increased ridership that will come with the addition of the 5.7 mile segment out to SeaTac. The RTA scaled up the results of the *Central Corridor* study by about 24% based on some limited additional modeling of the effect of adding the SeaTac link. The RTA's current forecasts of week-day ridership on the light rail line is 107,000, which is also about 24% more than forecast in the *Central Corridor* study.

The method for estimating travel time savings in the earlier study was carefully reviewed by the Expert Panel. The 24% increase in ridership and time savings to account for the SeaTac extension is an approximation, but it does not seem unreasonable given the earlier modeling. However, further analysis yields some results that are more troubling. Using the figures provided by the RTA in *Appendix C*, we calculated the implied time saving per passenger boarding on the rail elements of the plan at 8.5 minutes per boarding. This result is significantly higher than the *Central Corridor* study which showed travel time savings of only 2.1 minutes per boarding. While this level of travel time saving is plausible for commuter rail with an average trip length of twenty five miles, it stretches credulity as an average of commuter rail and light rail. The RTA estimates the average trip length of light rail users at 5 miles and its ridership is 91% of the total rail ridership. If the average total trip speed on transit (including waiting and walking time) were 10 miles per hour without the RTA, it would take 30 minutes to make a 5 mile trip. An average trip savings of 8.5 minutes per boarding implies that the average total trip speed will increase by 40% for all people using the RTA. Given the increased level of transfers from bus to rail transit and the length of walks within and to and from rail stations, it is difficult to imagine total travel time savings of that magnitude.

While we are skeptical about the RTA's claimed level of travel time saving given the high level of travel time savings per boarding, we have nonetheless relied upon the RTA's estimates in our analysis. However, we depart from the RTA's work in our estimate of the value of travel time, a value which they set at $12 per hour. Most studies of how people value their travel time indicate that people value their in-vehicle travel time at about half their wage rate. Indeed, most travel models (including PSRC's) use an even lower estimate, about 20% to 25% of the wage rate for the journey to work. The average regional wage rate is approximately $16.00 per hour. We therefore think $8 per hour is a more reasonable estimate of the value of time savings. In the study done for the federal government, the RTA was required to use a time value of $5.50 per hour. We tested the cost effectiveness of the RTA using a range of time values from $12 per hour to $6 per hour.

4.2. OTHER COST SAVINGS FOR TRANSIT USERS

In addition to saving time, people who would have driven cars and are induced to ride transit because of the improved service will also save the costs of operating and parking their vehicles. Estimates of these benefits rely on the RTA estimates of the number of new transit riders the system will attract and how many fewer miles they will drive their cars. In a report prepared for RTA member Rob McKenna, the RTA developed the data in the first two lines of Table 8 which shows their estimates of the new transit riders by mode. The last line shows the RTA's estimate of the annual reduction in vehicle miles traveled (VMT) using estimates of average trip length and vehicle occupancy.

Table 8. Estimates of New Riders Due to RTA System

	Express Bus	*Commuter Rail*	*Light Rail*	*Background Transit Network*	*Total*
RTA Estimates					
Daily New Riders	14,000	5,000	32,000	15,000	66,000
Annual New Riders (millions)	4	1	10	4	19
Annual VMT Reduction (millions)	na	na	na	na	127
ECONorthwest Estimates					
Daily New Riders	14,000	1000	24,000	15,000	54,000
Reduction in Daily Auto Trips	5,800	400	10,000	6,300	22,500
Annual New Riders (millions)	3.5	0.3	6.0	3.8	13.6
Average Trip Length (miles)	8	25	5	8	NA
Annual VMT Reduction (millions)	23	5	25	25	78

* This is attributed to the combined effect of greater transit system connectivity and reinvestment of bus hours.

Source: RTA *Appendix A: New Riders* and ECONorthwest calculations

The new riders for buses were estimated by RTA staff at 15 new riders for each hour of new bus service. The plan would add a total of 640,000 new hours of bus service per year. About half that would go to replacing existing bus routes and half would go into new express bus service.

The new rider figures for light rail relied on the same *Central Corridor* study used to estimate the time savings from rail investments. However, the earlier report shows only 19,200 net new daily riders from the new rail services while the table above shows 32,000 net new riders per day. This estimated increase is much higher than the earlier estimates of increases in travel time savings and ridership due to the SeaTac extension. In those cases, travel time and ridership were 24% higher; in this case new riders are 67% higher. After discussing this inconsistency with RTA staff, they conceded that 24,000 new riders per day for light rail was a more reasonable estimate given the analysis done in the earlier study.[4]

We are also skeptical of the new rider estimates for commuter rail. The RTA estimates weekday boardings on the commuter train at 12,600. With 5000 new riders the RTA is claiming that 40% of the riders on the commuter rail would not have been using transit before. Given that the commuter rail service is so similar in type and performance to existing express bus service, it seems unlikely that commuter rail will attract such a high percentage of new riders.

The studies of the southern commuter rail line indicated that commuter rail could provide service from Auburn to King St. station in 30 to 35 minutes. Current bus service, such as Route 150, takes 1:07 hours to get from Auburn to University Street station in the bus tunnel. Saving nearly half an hour could certainly attract new riders to commuter rail. However, the relevant comparison is between commuter rail and the future travel times on bus with a completed HOV system. For example, Route 175 now serves Federal Way with express bus service that takes 41 minutes to get from the University Street station to the Federal Way park-and-ride. Federal Way and Auburn are approximately equidistant from downtown Seattle. After accounting for the travel time from King St. station to other parts of downtown on the commuter rail line, there is virtually no time savings with commuter rail compared to express bus service; and rail provides much less frequent service. While buses serving Auburn do not currently have access to HOV lanes to the extent of those serving Federal Way, the currently funded portion of the HOV system will eventually reach to Auburn. With a completed HOV system, buses serving Auburn will have competitive travel times with commuter and offer trips every ten or fifteen minutes during the peak period compared to much less frequent service provided by commuter rail**.**

In the *Central Corridor* study new riders were only 7.4% of the total ridership on the light rail line. We think this is probably an upper bound on the percentage of new transit riders for commuter rail. If so, the commuter rail line will generate at most 1000 new transit riders per day.

Table 8 shows our revised estimates of new riders and VMT. The VMT reductions are calculated by multiplying the new riders times their average trip length by mode as reported in the RTA's travel model, then adjusting for an average vehicle occupancy of 1.2 persons per automobile. With these revisions the total annual new riders is reduced from 19 million to 13.6 million and the VMT savings is reduced from 127 million to 78 million.

This reduction in our estimate of the new riders and the VMT savings will, in turn, reduce the benefit estimates for parking cost savings, auto operating cost savings, and travel time savings for road users.

[4] Personal communication with Bob Harvey, RTA staff.

4.2.1. Parking

The RTA staff estimated savings from parking by multiplying the number of new round trips made on transit times the percent of commuters who pay for parking times the average cost of parking. They then deduct the costs of the transit fare for these riders. The RTA estimates that 50% of the trips no longer made in autos would have had to pay parking at an average cost of $5.00 per parking place. After adjusting this savings by the increased cost of the transit fare, the RTA estimates parking savings of $13 million per year.

We used the RTA's assumptions about the percentage of trips that pay parking and the average costs of parking but applied it to our lower estimate of new two-way transit trips. We estimate the parking savings to new transit riders at $14.2 million per year. Our estimate of parking savings is slightly higher than the RTA's because we do not deduct the additional fares paid by the new transit riders. We account for the increased payments in transit fares later in our analysis.

4.2.2. Auto Operating/Ownership Costs

New transit riders will also save the costs of operating their cars including gas, oil, tire wear, and regular maintenance. The RTA analysis used an assumption of $0.15 per mile. This rate does not include the full costs of auto ownership. The implicit assumption is that people will continue to own the same number of vehicles and at the margin will only save the costs of operating their vehicles when they choose to use transit. In our estimate, we combine the vehicle ownership and operating savings by using the value allowed by the Internal Revenue Service when deducting auto expenses, currently $0.31 per mile. We prefer to use this higher number because we believe that if people use their cars less, they will tend to replace them less frequently, and so over the long-run save more than just the vehicle operating costs. The rate we use is less than some other estimates of the full cost of ownership, which can exceed $0.40 per mile (Litman, 1994). Our estimate includes ownership as well as operating costs savings but makes some allowance for certain auto-ownership costs such as insurance and licensing that may not decrease when autos are driven less. Our estimate of these savings are $24.2 million, higher than the RTA's estimate of $19 million.

4.3. Travel Time Savings for Road Users

The RTA estimates that the travel time savings to private vehicles that remain on the road is $86 million. Our estimate of the benefit of freeing road capacity is considerably less, approximately one-tenth of the RTA's estimate. Part of the reason is our lower estimate of the VMT saved due to new transit riders; the much more significant reason is the measure of the benefit per reduction in VMT.

When the cars of new transit riders leave the highways they free up road capacity for those vehicles that remain on the roadways. Most of the road capacity freed up by transit riders is filled up with new drivers who will want to take advantage of the improved road conditions. Litman (1994) reports that for every 100 spaces freed up on a congested road, between 50 and 80 are filled up with additional vehicles. A more recent study by Hansen (1995) indicated that a 10% increase in highway capacity results in a 9% increase in travel demand within five years. This phenomenon of "latent demand" is why most new road capacity quickly fills up with new drivers and is also the reason the RTA has been candid about acknowledging that the plan will not improve traffic conditions on the region's highways. The main benefit of getting some people off the roads is that some new people will get to drive in nearly the same road conditions.

The value of this benefit has been estimated by a number of analysts. ECONorthwest (1994) conducted an analysis for the Puget Sound Regional Council which indicated that the cost of congestion averages about $0.07 per VMT in 1994 and will increase up to $0.12 per VMT by 2020. Litman (1994) surveyed the literature on this topic and recommended a congestion cost range in urban areas of $0.17 per VMT during peak periods. However, since not all of the RTA's new riders are coming out of the peak we would expect the average benefit per VMT reduced to be below $0.17. The RTA's calculation uses an implied benefit per reduced VMT that is four times this level. The RTA's analysis that results in a $86 million per year figure assumes that VMT reductions generate an average benefit of $0.68 per mile reduced. We know of no credible studies that support this high an estimate of benefits from VMT reductions. Our estimate is based on modeling work by the Puget Sound Regional Council. Our estimate of $0.10 per VMT for 2010 splits the difference between $0.07 in 1994 and $0.12 in 2020. Using a fairly optimistic[5] estimate of $0.10 per VMT reduced, the benefits of the RTA to road users are $7.8 million per year.

4.4. Reduced Costs for Employer Provided Parking

If the RTA plan causes some drivers to take transit instead of driving, then the parking spaces they use can be converted to other uses or made available to other drivers. The RTA estimated this benefit by multiplying the number of round trips to work times the percent of travelers who do not pay for parking times the value of each parking space. The RTA cited a study by Metro which indicated that the average annual cost per parking space to the owner is $1000 in the Metro service area. We have not had an opportunity to review that study but have used the same method with our revised estimate of new trips made on transit. The RTA estimated this benefit at $14 million per year; we estimate it at $11 million.

[5] The estimate is "optimistic" because the cost per VMT figures reflect the average value of the congestion externality imposed on drivers when the highway system is operating at optimal efficiency under a congestion pricing approach. Since the highways won't be priced, the value of the induced trips will be less on average than reflected in these figures.

4.5. Commercial Vehicles

The average value of travel time for commercial vehicles is significantly higher than those of commuters. The cost of running a commercial vehicle for an hour includes wages, benefits, vehicle operations, and the time value of the cargo. These costs in the Puget Sound have been estimated as high as $60 per hour (ECONorthwest, 1996). Even though commercial traffic is a small percentage of the total vehicle miles traveled in the region (less than 10%), the high value of time for these trips can yield significant benefits if highway speeds improve because of the transit investment.

For the RTA project, it is not clear that commercial vehicles driving on highways will enjoy any significant time savings. With private vehicles our estimate of the benefit per VMT reduced is mostly a proxy for the value of induced trips (and a high one at that). Commercial vehicles will make up a negligible percentage of these new trips, and those who do make new trips value the trips at the same rate as those made by private vehicles. Since neither we nor the RTA staff expect the current plan to yield any measurable improvements in travel time on the region's highway system, the vast majority of commercial vehicles will experience little benefit from the plan beyond that captured in the earlier estimate of the benefits to private drivers. The RTA estimated the benefit to commercial drivers at $13 million per year; we believe that there is no measurable benefit.

4.6. Transit Reliability

One of the advantages of rail transit is that service can be more reliable than bus transit. With exclusive right-of-way and few opportunities for roadway incidents to alter train schedules, rail transit is less likely to get off schedule and delay travelers. On the other hand, if one train stalls on the tracks, it slows down every train behind it until it is moved out of the way. The potential for enhanced transit reliability with rail is not accounted for in the typical travel models and its benefits are therefore not included in the estimates of travel savings and transit ridership. There are no well-accepted techniques for measuring this benefit of rail transit. The RTA has estimated the value of this benefit at 10% of the travel time savings. We are willing to accept the 10% of travel time savings estimate as a best guess with the caveat that the value of the benefit is quite uncertain.

4.7. Rail Freight Mobility

The improvements to the freight tracks that will run the commuter rail will also benefit the freight trains that use it. This is a real benefit, but we have not reviewed any data yet which allow us to calculate its value. Furthermore, we question the appropriateness of including this benefit in the evaluation of a plan focused on improving the mobility of people. The rail corridor in question is likely to experience significant increases in freight traffic over the next twenty years to serve the growth in container traffic through Port of Seattle's facilities at Harbor Island and elsewhere. Whether the RTA passes or not, this rail corridor will likely need investments to improve its performance in moving rail freight. If these improvements are indeed needed, then having the RTA pay for the improvements represents a shift in responsibility for financing additional rail capacity onto the general taxpayers and away from the Port of Seattle and freight movers.

The RTA has reported to us that rail freight movements add $100 million per year to the local economy. Even if this is true, the number doesn't help us estimate the benefits of improving rail freight performance along the commuter rail line. As with all the other benefits we have considered, were we to calculate this benefit we would need to estimate how much rail freight performance will improve with the RTA investments to begin to calculate its value.

4.8. CAPACITY FOR SPECIAL EVENTS

One advantage of the proposed rail system is the ability to serve the area around the Kingdome and new baseball stadium. Congestion around special events can be severe; the RTA would provide some additional capacity to move people in and out of a very congested area. This is a real benefit of the investment that is not captured in the existing travel models which focus on the journey between home and work. We have estimated the magnitude of these benefits and included them in the range of benefits considered in the evaluation.

According to the *Central Corridor Study*, the light rail system will have a peak one-way capacity of 4,300 passengers per hour. Assume there are 100 events per year, and that for one hour before and after the event the light rail system operates at peak capacity in both directions carrying only event patrons. Further assume that each rider saves ten minutes in time compared to their alternatives without the light rail line and that the value of their time is $8 per hour. These assumptions yield an annual benefit of $2.3 million per year. This estimate is a reasonable approximation of the potential benefit of the added capacity to serve special events.

4.9. IMPROVED SAFETY

The proposed improvements to the HOV system will allow buses and carpool drivers direct access to the HOV lanes instead of having to weave through general purpose traffic. This will generate real benefits in terms of the reduced stress involved in getting into the HOV lanes and fewer accidents from people weaving in. This benefit is difficult to estimate but is a likely benefit of the plan that voters should consider even if we cannot estimate its value.

4.10. IMPROVED ROAD RELIABILITY

The RTA claims that the plan may improve road reliability for non-transit users. We think this benefit is likely to be very small. As discussed earlier, much of the traffic that shifts on to transit will be replaced by new drivers on the freeways. The congested conditions that lead to highway incidents and unreliable travel times are likely to persist. Travel times on transit will be more reliable with the RTA system but it is unlikely that roadways will be more reliable with the proposed plan.

4.11. OTHER TRANSPORTATION BENEFITS

The RTA lists several other transportation benefits that are slightly different from those already discussed:

- New people moving capacity
- Preservation of transit travel times through dedicated right-of-way
- Improving transit mobility for “choice” and “dependent” riders

The benefits of new people moving capacity are already included in the estimates of ridership and travel time savings. The only benefits of new capacity are those associated with using it. There is some argument to be made, however, for redundancy. In the 1989 earthquake in San Francisco, several key roadways were disabled. BART’s ridership increased substantially and offered much needed capacity at the time. The ridership on the RTA’s rail line could also go up significantly if an earthquake disabled a major portion of I-5 and rail transit was the only way to cross the ship canal or get to downtown Seattle from the airport. Redundancy is a real benefit but very difficult to quantify. Its utility requires a cataclysmic event that disables other transportation links but leaves the RTA intact.

Preserving transit travel time through dedicated right-of-way is mostly reflected in the travel time analysis. The RTA staff have expressed the opinion that the benefits of preserving travel times on exclusive right-of-way will increase over time as the conditions on the regional highways deteriorate. This is a plausible position and one we evaluate in the next section.

The third point is a bit vague but seems to be addressing the potential benefits of the plan for low-income people or “dependent riders”. The mobility benefits of the plan are already estimated in the other categories of benefits, so this point seems to suggest that the RTA system will provide better transportation services for people with low incomes. The light rail line goes through the Rainier Valley in Seattle and may indeed provide better transit service for some low-income households. It is difficult to evaluate the plan’s overall effect on equity because significant resources are serving higher income areas as well. We think it is possible that some people with low incomes who live close to improved transit service will be better off with the RTA plan than without it. However, voters concerned about equity should also consider the effects of the sales tax increase on those with low incomes. The sales tax is a regressive tax, which means that those with low incomes will pay a higher proportion of their income to support improved transit service than those with high incomes. Many low-income people in the region who will pay the tax increase are unlikely to enjoy transit benefits that exceed the amount of their tax increase.

5. EVALUATION OF TRANSPORTATION BENEFITS AND COSTS OVER TIME

The preceding section compared the RTA's estimates of the benefits of their proposal with our revision of those estimates for one point in time, the year 2010. The RTA estimates the annual benefits at $250 million in that year; we estimate them at $132 million. In this section we project the benefits and costs of the proposal over the next thirty-three years and then compare the value today of the stream of benefits and costs. There is always uncertainty when forecasting the future; we therefore test a range of values for some of the key assumptions in the analysis.

5.1. ASSUMPTIONS USED IN ANALYSIS

Inflation

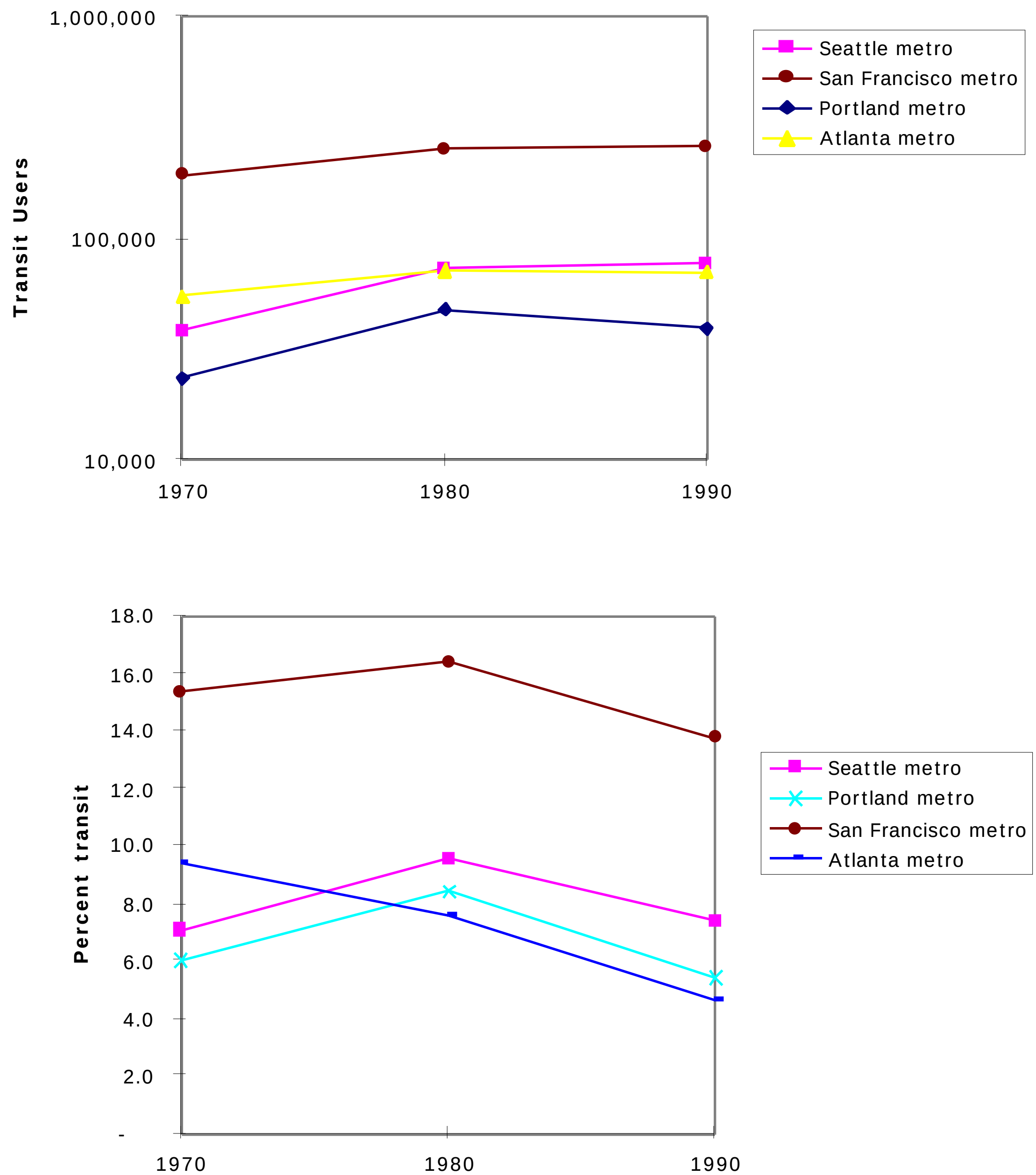
All of the costs and benefits are expressed in constant 1995 dollars. Thus the growth rates used are "real" growth rates after removing the effects of inflation.

Benefit Growth Rate

Our estimates of the RTA plan's benefits are for the year 2010. To estimate the benefits from 1997 to 2010 we have made a straight line projection from zero to our estimate of the 2010 benefits. This approach reflects the fact that the system will be under construction during that period and will not start generating full benefits until 2010. From 2010 to 2030 we test a range of assumptions. In an earlier version of *Appendix C*, the RTA forecast the benefits after 2010 assuming a 1.6% growth rate, which is the projected rate of population increase in the region. In the final version of the study, the RTA choose not to forecast the growth rate in benefits because they felt there was not enough data to support a definite conclusion.

In most regions with rail and bus transit, the percentage of trips on transit has declined over time in spite of investments in increased transit capacity. Figure 1 shows the number of trips to work made on transit and the percent of trips made on transit in three areas that have made significant investments in transit: Atlanta, San Francisco, and Portland, Oregon. Atlanta has the MARTA rail system, the Bay Area has BART and Portland has MAX. Seattle information is also included in the figure. One can see that transit ridership in areas with significant transit investment has increased slightly since 1970 and has been flat or dropped since 1980. In the period between 1970 and 1980 labor force participation by women increased significantly, and the oil shortage of 1979 tended to boost transit ridership in 1980. Since 1980, oil prices and female labor force participation have not changed much, and transit mode share has steadily dropped. Our review of these data indicate that areas experiencing population growth that invest in rail transit will tend to maintain existing transit ridership and decreasing transit mode share.

Figure 1. Journey-to-Work Transit Users and Transit Mode Share in Metropolitan Areas Investing In Transit: 1970 to 1900



Source: U.S. Census

If the region invests in the current RTA plan and does not vote for further expansion of the system, we think the benefits associated with the "starter rail" link will decline over time. Other regions have had to keep investing in rail transit to maintain constant ridership; without ongoing investment, ridership declines. For this analysis we have made the more generous assumption that the trend in travel benefits from the RTA will not decline but remain constant or have a growth rate of zero.

There is a plausible argument that is made by the RTA staff that as the performance of the highway system declines over time, the relative time savings of transit may increase, and more and more people will use transit. We test this idea by evaluating a benefit growth rate of 1.5% per year. This is the rate of increase in transit mode share that would have to occur to reach the Puget Sound Regional Council's target in the Metropolitan Transportation Plan for 2020. That plan assumes completion of the full regional rapid transit system.

Operations and Maintenance Cost Growth Rate

As discussed in Section 4, average operating and maintenance costs per rider have increased at an average rate of 4% above inflation for the last fifteen years for transit agencies nationally. We do not know if this trend will continue indefinitely but given labor's high percentage of transit costs, it seems likely that operating and maintenance costs will increase more rapidly than inflation. We estimate a growth rate in operating and maintenance costs of 1% over the inflation rate; we test a range of assumptions from 0% to 2%.

Discount Rate

The discount rate is the rate used to estimate the value today of future costs and benefits. It is closely related to the rate of return on investments in the private economy. The logic of using a discount rate is that if the public sector is going to take money out of the private sector and spend it on a public good, the return on that investment over time should be at least as high as it would be if the money had remained in the private sector. We use a fixed rate of 4%, which is approximately the rate for long-term borrowing by blue chip companies after removing inflationary expectations. This estimate is generally consistent with the approach recommended by the General Accounting Office (1991), but considerably lower than other recommended rates. The federal Office of Management and Budget has recommended real discount rates as high as a 10%. Using a lower rate like 4% tends to favor investments like the RTA, which have most of their costs up front and most of their benefits in the future.

TSM Factor

Most of the travel performance data developed for the RTA compared the RTA plan with a Transportation System Management (TSM) plan. The TSM alternative was included as a subset of the RTA plan. The RTA describes TSM as follows:

> "The Transportation System Management (TSM) forecast reflects transit ridership growth due to population and employment increases, completion of the state Department of Transportation Department's core HOV system and those transit service increases that can be paid for within existing transit agency tax sources."
> (RTA, *Appendix C*, C-3)

The TSM scenario is the baseline against which the costs and benefits of the RTA plan is measured. In our conversations with the RTA staff, they have contended that their analysis underestimates new riders and travel time savings because the TSM plan as modeled will not actually happen. They argue that if the RTA plan was compared to a true base case the travel time savings and new transit ridership would be significantly higher. This position disagrees with how they describe TSM in their most recent report but we have nonetheless considered it.

Given our analysis of the estimated travel time savings per boarding, which seemed quite high, we think it unlikely that the actual travel time savings from the RTA are greater than those that they report. Our estimate of the travel time savings is the same as that used by the RTA, but with a lower value of time. To test the RTA's contention about the effects of using TSM as the base case, we have included a "TSM Factor" which takes the total benefit estimate and increases it by 20%. This factor is simply a way of answering the question, "Suppose the plan's annual benefits are 20% higher than the travel modeling indicates?' At the other end, we test the assumption that benefits are 20% lower than claimed to account for the RTA's high estimate of time savings per boarding.

Value of Time

The value of travel time is a key assumption in this analysis. The RTA uses $12 per hour which is considerably higher than typically used in these types of evaluations. We estimate $8 per hour, half the regional wage. This is the level recommended by Small (1992) in his book on transportation economics. We test a range from $12 to $4 per hour. The most conservative assumption here is the implied value of time in the regional travel models.

Benefits to Road Users Per VMT Reduction

Our estimate of the benefits to road users per reduction in vehicle miles traveled is $0.10. As discussed in Section 4, this estimate comes from a study done in the Puget Sound region of the average value per mile of the marginal trips made in the region (ECONorthwest, 1994). We test a range of benefits to road users caused by removing vehicles from the road from $0.17 to $0.03 per mile. The top of this range is Litman's (1994) estimate of the value of removing traffic from a congested urban freeway during peak periods. Since not all of the reduced VMT are from the peak, this is a high estimate. The $0.03 is near Litman's minimum estimate of the benefits of reducing congestion in an urban area.

5.2. Results of Analysis

Using the above estimates, we can forecast the pattern of benefits and costs over time using our estimate of the annual benefits of the plan in 2010 and the RTA's estimate. Figure 2 shows our estimate of the stream of benefits and costs; Figure 3 shows the same cost forecast with the RTA's estimates of benefits for the year 2010 projected over thirty-three years. What is significant in both figures is how much the costs of the project are skewed towards the first ten years while the benefits occur mostly in the future.[6] The large benefit in the year 2030 reflects the residual value of the system at that time. The increased costs in 2017, 2022, and 2027 reflect capital reinvestment necessary to replace capital stock as it wears out.

Figure 2. Benefits and Costs Over Time Using ECONorthwest Assumptions of Annual Benefits

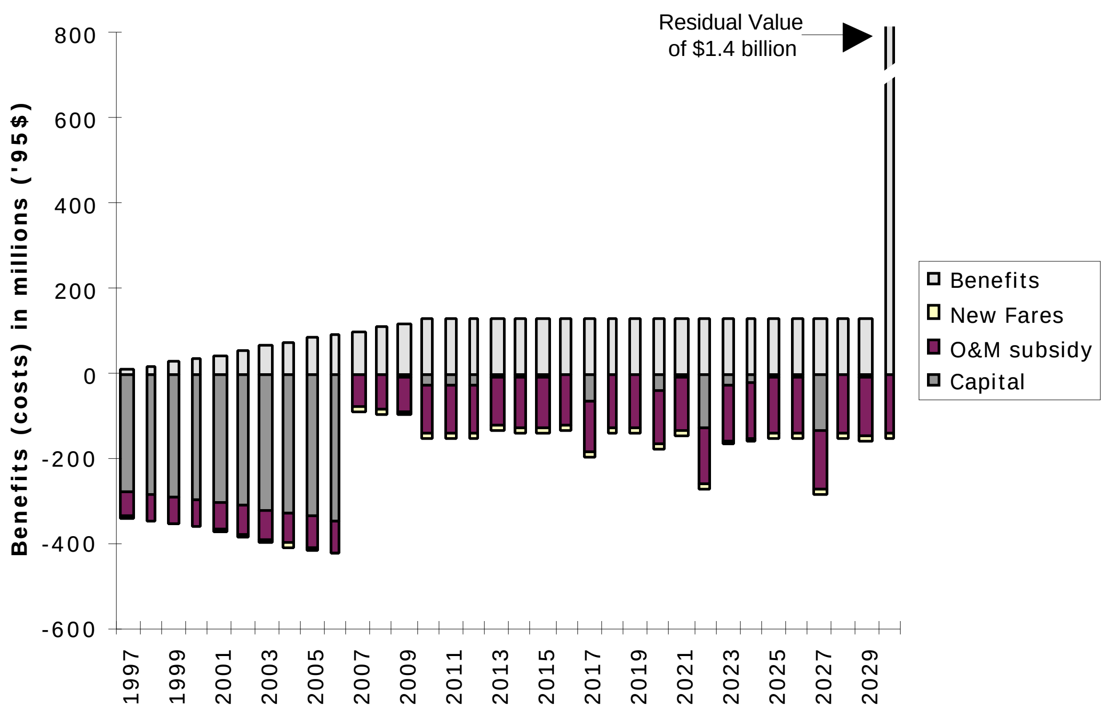
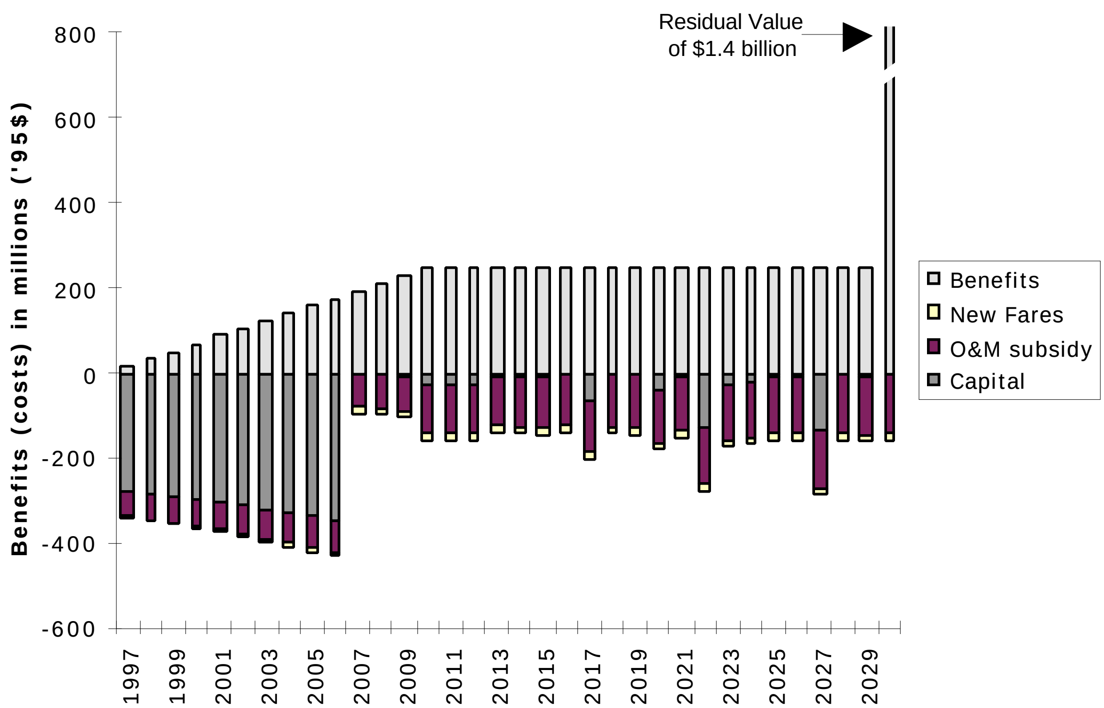


Table 9 shows the net benefits of the RTA plan using both our assumptions about the benefits and the assumptions of the RTA. Our analysis indicates that the present value of costs of the RTA plan exceed its benefits by $2.5 billion. Using the RTA's assumptions of the benefits, which puts high values on travel time savings and removing traffic from the highways, the plan's costs still exceed its benefits by $1 billion. The implied internal rate of return on the investment in the RTA is minus 4.1% using our assumptions and 1.1% using the RTA assumptions. The annualized cost per new transit rider over the thirty years is about $13,000 with our revisions and over $9,000 with the

[6] The graph does not show debt service but rather the actual capital and operations and maintenance expenditures in the year they occur. An alternative way of presenting the costs would show the debt service on the borrowed capital. In terms of calculating the net present value, these two methods of allocating costs over time have the same effect if the real discount rate and the real borrowing rate on the bonds are the same. The 4% real discount rate we use here is approximately equal to the RTA's estimate of tax-exempt borrowing after removing the effects of inflation.

RTA assumptions. This last figure represents an annualized estimate of the capital and operating cost of the system divided by number of new transit riders.[7]

Figure 3. Benefits and Costs Over Time Using RTA's Assumptions of Annual Benefits



[7] This number is calculated by dividing the present value of all the costs of the project by the present value of the number of new transit riders per year. Annual new riders per year is calculated by dividing the number of new transit trips per year by 250 (the number of commuting days per year) and dividing again by 2 (to reflect that each rider makes 2 trips per day).

Table 9. Evaluation of Transportation Benefits and Costs of the RTA over Thirty Years

	ECONorthwest Assumptions	*RTA Assumptions*
Benefits Minus Costs (millions)	($2,464)	($985)
Rate of Return	(4.21%)	1.07%
Annualized Cost per New Transit Rider	$13,028	$9,314
Assumptions	2010 benefits as listed for RTA and ECONorthwest in Table 6. Discount rate: 4%, Benefit growth rate: 0%, Maintenance cost growth rate: 1%, RTA's stated estimates of capital and operating costs.	

We have tested the degree to which changing key assumptions in the analysis varies the result. Using our estimate of net benefits as a base we analyzed how the results changed as we varied each assumption. Table 10 shows the results of varying the assumptions on the benefit growth rate, the growth in maintenance costs, the value of time, the benefits of reduced VMT, and a TSM factor to increase the estimated benefits. The parameters that have the most significant effect are the value of time and the TSM factor. Within a reasonable range of these values no one parameter changes the net benefits of the RTA plan by more than 16% of our base value of costs exceeding benefits by $2.5 billion.

The RTA has asked us to consider the net benefits of the plan not counting the costs that will be paid by the federal government. We think this is not the proper analytic approach since the federal money represents real resources that should not be dissipated. However, adopting the view the federal share of the RTA does not count as a cost to the region, the plan's costs still exceed its benefits. Assuming that the federal government paid its $727 million share immediately, the present value of the plan would still be a minus $1.8 billion for the region.

Table 10. Sensitivity Analysis on Key Assumptions

	Most Favorable to RTA	——>	————————>		Least Favorable to RTA
Assumptions	**1**	**2**	ECO's values	**3**	**4**
Benefit Growth Rate	1.50%	0.75%	0%	-0.75%	-1.50%
% Change in Net Benefit*	5.5%	2.6%	0%	-2.4%	-4.6%
O & M Growth Rate	0.0%	0.5%	1%	1.5%	2.0%
% Change in Net Benefit	8.4%	4.4%	0%	-4.9%	-10.4%
Value of Time	$12.00	$10.00	$8.00	$6.00	$4.00
% Change in Net Benefit	15.9%	8.0%	0%	-8.0%	-15.9%
Driver Benefits per VMT Reduction	$0.17	$ 0.14	$0.10	$ 0.07	$0.03
% Change in Net Benefit	2.3%	1.3%	0%	-1.0%	-2.3%
TSM Factor	1.2	1.1	1.0	0.9	0.8
% Change in Net Benefit	10.7%	5.3%	0%	-5.3%	-10.7%

*Changes relative to base estimate

The analysis in Table 9 indicates that the RTA is not a cost-effective transportation investment if its only benefits are the changes in transportation performance we have estimated above. Nearly all of the relevant transportation costs and benefits have been included in this analysis. On the cost side we have left out the costs of construction delay, on the benefit side we have left out the value of safety improvements and the improved performance of rail freight on the commuter line corridor. We do not think that including these categories would substantially improve the results for the RTA. Since delay costs can be quite large and occur early, they are likely to outweigh any safety and rail freight benefits.

5.3. NET BENEFITS OF HOV LANES & BUSES

Taken in its entirety the RTA plan does not meet the basic investment criterion of having transportation benefits that exceed its cost. However, some elements of the RTA Plan are quite cost effective. Most economists who analyze transit policy have argued that buses offer a more cost-effective alternative to rail transit (Kain, 1995; Keeler and Small, 1975). Buses perform best when they are granted clear right-of-way on high occupancy vehicle (HOV) lanes.

Our analysis of the data used to support the investments in bus access to the HOV system indicate that many of the bus access projects included in the

RTA plan are cost-effective transportation investments. The state Department of Transportation conducted a study of the travel time savings of enhancements to the HOV system that was independent of the RTA's modeling. Their estimates of travel time savings were based on existing carpools and bus routes and did not account for some of the system-wide benefits of a fully integrated HOV system. The HOV investments that were included in the RTA plan were those that allow buses and carpools direct access to the HOV lanes without having to cross over general purpose lanes that are moving slower than the HOV lanes. The following table shows several of these direct access projects, their estimated cost, and the net benefits and rate of return on the investment. The benefit estimates for these investments are based on existing bus routes. If additional routes were added, the net benefits would be greater.

Table 11. Cost-effective Elements of the RTA Plan: Direct Access to HOV Lanes

Location	*Cost ($ millions)*	*Benefits Minus Costs ($ millions)**	*Rate of Return*
164th Street SW & SR 525	$1.98	$36.26	106%
I-5 Ex/NE 50th Street HOV Ramp	$ 6.04	$12.50	18%
I-5/NE 145th St	$ 8.83	$9.88	13%
I-5/S 320th St.	$23.71	$19.41	11%
I-5/E-3 Busway	$46.09	$26.81	9%
I-5/S 272nd St	$ 26.98	$3.86	6%
164th/ Ash Way P&R /I-5	$10.85	$0.49	5%
Bellevue CBD	$65.95	$0.67	5%

*Present value (benefits minus costs) estimated using a 5% real discount rate. Source: *Travel Time Savings Summary Report, Puget Sound HOV Pre-Design Studies Phase II,* 1996; benefits estimated by ECONorthwest.

The greater cost-effectiveness of buses and HOV lanes is also reflected in the data on new riders. Table 7 showed that new riders from buses make up over half of the new riders from the RTA plan. However, bus service, HOV access, and community connections receive only one quarter of the investment from Sound Move. With only 25% of the investment, bus service generates over half of the new riders. Cost-effective investments in improved bus service and HOV lanes can provide more transportation benefits for less money than the existing plan with its emphasis on rail transit.

6. OTHER BENEFITS

The RTA's *Appendix C: Benefits, System Use and Transportation Impacts of Sound Move* provides a list of the systems non-transportation benefits to which the RTA could not assign dollar values but which they nonetheless determined to be real benefits which voters should consider. In this section, we discuss these categories of benefits.

Table 12. Non-Transportation Benefits and Comments

Non-Transportation Benefits Claimed by RTA	Summary Comments
Increased property value near transit stations	May occur but represents the capitalization of travel time savings. Including dollar value double counts travel time savings
Construction and related employment	Federal money assumed for these effects may be available for other projects; Puget Sound region is already near full employment
Increased commercial activity: • New businesses • Retain existing businesses • Tourism	If RTA represents cost-effective transportation investment, then small effects possible. If not cost effective, then little or negative effect on overall economic activity
Air quality and health benefits	Very small; most of the auto travelers moved on to transit will be replaced by new auto drivers. Also, auto access trips to transit will generate pollution
Urban Form • Increased connection between centers • Reduction of sprawl • Enhanced pedestrian environment	Investments in radial transportation systems, whether road or transit, tend to increase sprawl. Enhanced pedestrian environment is a benefit, but small percent of plan goes into this.
Integrating fare systems	Integration may be a convenience for some but can also lead to inefficient pricing policies

6.1. Increased Property Values Near Transit Terminals

The RTA lists as one of the benefits of the plan the potential increase in property values near transit terminals. While the RTA does not report a dollar value for this effect, its inclusion with the list of other benefits suggests that this benefit should be added to the other benefits of the RTA. The economics literature is very clear that the changes in land values near transit stations is primarily a capitalization of travel time savings. To count both travel time savings of a transit investment *and* the increases in property values therefore counts the transportation improvements twice. The authority that the RTA cites for this benefit, a 1994 article by Landis, Guhathakurta and Zhang, begins with a ready acknowledgment of this fact; "The assumption that accessibility is capitalized into property values lies at the heart of contemporary urban economics." What is particularly worth noting in their study is that of five rail transit systems they analyzed, only two, BART and San Diego Trolley, showed evidence of higher property values near transit terminals. The authors conclude, "Although the existence of transit price premiums may be evident in retrospect (as in the case here [with BART and San Diego]), they are certainly not guaranteed before the fact." That is to say that the other systems they studied—San Francisco commuter rail, Sacramento and San Jose light rail—did not generate enough accessibility benefits to cause significant effects on the property near their transit terminals. The RTA's own citation on this issue not only refutes the RTA's position of double counting accessibility benefits and changes in property values, but also indicates that the transportation benefits of rail are so low in three out of the five cases that the researchers could detect no change in neighboring property values.

6.2. Construction Employment

Whether employment is an additional benefit is a matter of perspective. If outside (federal) money came into the region that *would not otherwise* have come in, then it could potentially creating new employment and employment multipliers. If RTA were paid for only with local money, there would be no effect on employment, since the taxpayers in the region have discretion to spend the same amount of money on other employment-producing projects like building low-income housing or adding teachers to schools.

The RTA contends that the plan will generate between $78 and $118 million in construction and related employment per year during the ten years the project is under construction. This amount is based on the $727 million in federal subsidy that is part of the plan. If this federal money actually comes through, then the RTA's stated range is a reasonable estimate of the likely employment effects of proceeding with the project. However, there are several issues that voters should consider in evaluating this potential effect of the project:

- Will the federal money really come through? The RTA feels confident of its eligibility, but the fiscal climate in Washington has changed and the federal match is not guaranteed.
- Will other federal spending in this region be displaced by the federal RTA match? Will the political process in Washington D.C. determine that with the RTA the Puget Sound has gotten its share of federal money and limit other spending here so that no net increase in federal funding occurs?
- The recent federal transportation legislation (ISTEA) provides greater flexibility in using transportation dollars. Other types of transit investments other than the current RTA plan could also be available for federal funding that would have similar employment effects.

Voters should also consider whether increasing employment is a proper policy objective given that the region is currently near full employment. The cover story in the August 21st, 1996 *Journal American* led with the following title: “Area employers feel squeeze as jobless rate dips”. The current issue for the local economy is not the lack of jobs but rather finding enough qualified workers. The renewed strength of Boeing and the ongoing growth in the high technology sector present a very positive economic outlook for the rest of the decade. While the RTA’s claimed contribution to regional employment is relatively small (less than 0.1%) it nonetheless comes at a time when the regional economy is growing at a healthy rate.

6.3. Increased Commercial Activity

The RTA lists the attraction of new businesses, the retention of existing businesses, and increases in tourism as benefits of the RTA. The contention seems to be that the overall level of economic activity in the region will be higher with the plan than without it. This argument is plausible if the RTA represents a truly cost-effective investment. If by shifting resources out of private consumption and investment and into transportation capacity the region will generate transportation benefits that substantially exceed the costs, then the region will have added productive capacity that could raise the overall level of economic activity. However, if the RTA plan fails the benefit-cost test, then it represents the diversion of resources into less productive uses than would occur if these resources remained in the private economy. Our previous analysis showed that the RTA plan fails the strict benefit-cost test; thus the overall level of economic activity in the region is unlikely to increase with the RTA plan.

That is not to say that particular businesses in some geographic areas would not do better with this investment. The rail connection from the University of Washington to downtown to the airport will indeed benefit the businesses and institutions close to the rail stations. However, other businesses will be made slightly worse off as consumers have less money to spend due to the increase in the sales tax and motor vehicle excise tax. Overall, the regional economy will not perform better with this investment and may indeed perform slightly worse.

RTA supporters assert that the new transit system will attract more tourists to the region than would come without the new transit system, and that these new tourists will boost the local economy. It is difficult to evaluate this assertion, although it seems unlikely that tourists visit a particular location because of its transit system. If it is very easy for tourists to get around, then perhaps the region's reputation as a tourist destination would increase and we would have more visitors. The RTA plan may increase tourism but it is impossible to say by how much; and an alternative system (e.g., one aimed at linking tourist destinations) might also achieve the same objective.

6.4. AIR QUALITY BENEFITS

The automobile contributes a significant share of the airborne pollutants to the region. By getting some people to take transit instead of their cars, the RTA could lead to improved air quality. The current RTA plan is unlikely to have significant effects on regional air quality because of latent demand: when some people choose to get out of their cars and take the bus or the train to work, new auto drivers will take their place on the roadways. Any capacity that is freed up on the highways will quickly be used by new drivers who will continue to emit air pollution.

The Puget Sound Regional Council's Metropolitan Transportation Plan (MTP) shows that in 2010 the peak period carbon monoxide levels are the nearly the same with or without the RTA plan. Peak period carbon monoxide emissions are 347 metric tons daily with the baseline forecast and 344 metric tons daily with the action alternative that includes the RTA. In 2010, the RTA plan and the other improvements in the MTP change all categories of peak period emissions by less than 1%. Most of the improvements in future air quality will come from improvements in auto emissions technology rather than from people switching from cars to transit.

6.5. URBAN FORM

Much has been made of how the RTA's plan will help the region achieve its growth management objectives. For many supporters this aspect of the plan is the most important. The RTA's list of system benefits includes:

- Reduction of sprawl
- Increased connection between centers
- Enhanced pedestrian environment

One of the key issues for the public to consider is whether the RTA will indeed reduce urban sprawl. Unfortunately, there is no compelling evidence that investments of the type contemplated by the RTA will tend towards supporting higher residential densities; in fact, the opposite could occur. In general, investments in radial transportation capacity (from the center out to the edges of the urban area) tend to increase sprawl. If it takes less time to travel from the periphery to downtown because of either road or transit improvements, then more people will be willing to live farther away from the region's center.

To the extent that investments in HOV lanes and bus service reduce travel times for people living in the suburbs, then these investment may tend to encourage sprawl. This is especially the case with the addition of more park-and-ride capacity along the regional freeways. Park-and-rides allow people to live in traditional suburban densities and then drive their car to a transit stop that offers quick, reliable service to their ultimate destination.

The region's planners want to avoid this trend by developing regional centers with higher densities that would provide origins and destinations for transit trips. However, the real estate market is largely driven by people's preferences for housing and will usually not support the higher densities envisioned in the region's land-use plan. The study of land values near the five California rail systems cited by the RTA summarizes its findings as follows:

> The first policy conclusion is that the capitalized housing price premiums associated with BART access, as significant as they are, are not large enough to promote higher residential densities. Even in the best of cases, the market, left to its own devices, is unlikely to generate significantly higher residential densities near transit stations. Supportive land-use policies––and in many locations, development subsidies or incentives—are necessary to support the development of higher-density housing at or near transit stations. (Landis, Guhathakurta and Zhang, 1994)

As stated above in the Landis study, only two of the five rail systems had any effect on land-prices at all. Given the limited scope of the current RTA plan as a "starter rail line" it seems very unlikely that these transit investments will spur significant increases in density without other public policies to motivate higher density.

What this result means is that the RTA's investment will provide very weak economic incentives for the kinds of development patterns that the region has adopted in its land-use plan. In fact, the increase in highway capacity with HOV lanes and park-and-ride lots may tend to increase sprawl beyond what would occur without those investments.

7. CONCLUSION

This study used the analytic tool of benefit-cost analysis to evaluate the cost-effectiveness of the RTA proposal. As Richard Zerbe and Dwight Dively write in their textbook on benefit-cost analysis, "Decisions are made by decision makers, and benefit-cost analysis is properly regarded as an aid to decision-making and not the decision itself." This report is intended to provide additional information for voters to consider as they make their own individual decisions about the merits of the RTA proposal.

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9. APPENDIX A: BENEFIT-COST WORKSHEETS

9.1. BENEFITS AND COSTS OVER TIME OF RTA PLAN: ECONORTHWEST ESTIMATES OF BENEFITS

Analytic Assumptions		**Benefits Assumtions**	ECO Estimates
Ridership Growth Rate:	0.0%	Time savings for system users	65.6
Benefit Growth Rate:	0.0%	Parking cost savings for system users	14.2
O&M Growth Rate:	1.0%	Reduced auto operating costs	24.2
Real Discount Rate	4.0%	Travel benefits for private vehicles	7.8
TSM Factor:	1.00	Reduced employer-provided parking	11.1
Value of Time:	$ 8.00	Mobility for commercial vehicles	0.0
Per mile auto operating costs:	$ 0.31	Bus service replaced by RTA	0.0
Benefits to Drivers per VMT Reduced	$ 0.10	Improve transit reliability	6.6
Base O&M Costs in 2010:	100	Special Events	2.3
Residual Value:	1,400	Total Benefits	131.7
Fare Per Trip:	0.85	New Trips	13.4

Net Benefits of Proposed RTA Plan

All costs in millions of 1995 dollars.

Year	Capital	O&M subsidy	Capital + O&M Subsidy	New Fares	Total Costs	Travel Benefits & Residual Value	New Trips Per Yr (million)	Annual Net Benefits
1997	274	60	334	1	335	9	1	-325
1998	281	62	342	2	344	19	2	-325
1999	288	63	351	2	353	28	3	-325
2000	295	65	360	3	363	38	4	-325
2001	302	66	369	4	373	47	5	-326
2002	310	68	378	5	383	56	6	-326
2003	317	70	387	6	393	66	7	-327
2004	325	72	397	7	403	75	8	-328
2005	333	73	407	7	414	85	9	-329
2006	342	75	417	8	425	94	10	-331
2007		77	77	9	86	104	11	18
2008		79	79	10	89	113	11	24
2009	5	81	86	11	97	122	12	26
2010	23	114	137	11	148	**131.7**	**13.40**	-16
2011	24	115	139	11	150	132	13.40	-19
2012	21	116	137	11	149	132	13.40	-17
2013	5	117	122	11	134	132	13.40	-2
2014	5	118	123	11	135	132	13.40	-3
2015	5	120	125	11	136	132	13.40	-4
2016		121	121	11	132	132	13.40	0
2017	63	122	185	11	197	132	13.40	-65
2018		123	123	11	135	132	13.40	-3
2019		124	124	11	136	132	13.40	-4
2020	38	126	163	11	175	132	13.40	-43
2021	5	127	132	11	143	132	13.40	-12
2022	127	128	256	11	267	132	13.40	-135
2023	24	130	154	11	165	132	13.40	-33
2024	19	131	150	11	161	132	13.40	-29
2025	5	132	137	11	149	132	13.40	-17
2026	5	133	138	11	150	132	13.40	-18
2027	131	135	266	11	278	132	13.40	-146
2028		136	136	11	148	132	13.40	-16
2029	5	137	142	11	154	132	13.40	-22
2030		139	139	11	150	1532	13.40	1381
Total:	3,577	3,556	7,133	313	7,446	5,023	369	(2,423)
1st 10 yrs	3,066	674	3,740	**PV**	4,549	2,085	175	(2,464)
Capital Replacement	511			**Net Benefit**				(2,464)
				Rate of Return				-4.21%
		Cost Per New Transit Rider Per Year						$ 13,028

9.2. BENEFITS AND COSTS OVER TIME OF RTA PLAN: RTA ESTIMATES OF BENEFITS IN *APPENDIX C*

Analytic Assumptions		**Benefits Assumtions**	RTA Mid-point
Ridership Growth Rate:	0.0%	Time savings for system users	98
Benefit Growth Rate:	0.0%	Parking cost savings for system users	13
O&M Growth Rate:	1.0%	Reduced auto operating costs	19
Real Discount Rate	4.0%	Travel benefits for private vehicles	86
TSM Factor:	1.00	Reduced employer-provided parking	14
Value of Time:	$ 8.00	Mobility for commercial vehicles	13
Per mile auto operating costs:	$ 0.31	Bus service replaced by RTA	0
Benefits to Drivers per VMT Reduced	$ 0.10	Improve transit reliability	7
Base O&M Costs in 2010:	100	Special Events	0
Residual Value:	1,400	Total Benefits	250
Fare Per Trip:	0.85	New Trips	19

Net Benefits of Proposed RTA Plan

All costs in millions of 1995 dollars.

Year	Capital	O&M subsidy	Capital + O&M Subsidy	New Fares	Total Costs	Travel Benefits & Residual Value	New Trips Per Yr (million)	Annual Net Benefits
1997	274	60	334	1	335	18	1	-317
1998	281	62	342	2	345	36	3	-309
1999	288	63	351	3	354	54	4	-301
2000	295	65	360	5	364	71	5	-293
2001	302	66	369	6	374	89	7	-285
2002	310	68	378	7	385	107	8	-278
2003	317	70	387	8	395	125	10	-270
2004	325	72	397	9	406	143	11	-263
2005	333	73	407	10	417	161	12	-256
2006	342	75	417	12	428	179	14	-250
2007		77	77	13	90	196	15	107
2008		79	79	14	93	214	16	121
2009	5	81	86	15	101	232	18	131
2010	23	114	137	16	153	**250.0**	**19.00**	97
2011	24	115	139	16	155	250	19.00	95
2012	21	116	137	16	154	250	19.00	96
2013	5	117	122	16	138	250	19.00	112
2014	5	118	123	16	140	250	19.00	110
2015	5	120	125	16	141	250	19.00	109
2016		121	121	16	137	250	19.00	113
2017	63	122	185	16	201	250	19.00	49
2018		123	123	16	139	250	19.00	111
2019		124	124	16	141	250	19.00	109
2020	38	126	163	16	180	250	19.00	70
2021	5	127	132	16	148	250	19.00	102
2022	127	128	256	16	272	250	19.00	-22
2023	24	130	154	16	170	250	19.00	80
2024	19	131	150	16	166	250	19.00	84
2025	5	132	137	16	153	250	19.00	97
2026	5	133	138	16	155	250	19.00	95
2027	131	135	266	16	282	250	19.00	-32
2028		136	136	16	152	250	19.00	98
2029	5	137	142	16	159	250	19.00	91
2030		139	139	16	155	1650	19.00	1495
Total:	3,577	3,556	7,133	444	7,577	8,275	523	698
1st 10 yrs	3,066	674	3,740	**PV**	4,611	3,626	248	(985)
Capital Replacement	511			**Net Benefit**				(985)
				Rate of Return				1.07%
		Cost Per New Transit Rider Per Year						$ 9,314

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