Note: This is an unpublished working draft document obtained by Public Interest Transportation Forum. The paper is an intermediate result prepared by Puget Sound Regional Council staff under a contract with Sound Transit, but not released by either agency. It provides insight into staff work by PSRC that attempts to find and portray Sound Transit investments beyond the initial Sound Move Plan to be as beneficial as possible.

DRAFT

Potential Economic Benefits of the Long-Range Regional High Capacity Transit System

Prepared for Sound Transit

by

Puget Sound Regional Council
1011 Western Avenue Suite 500
Seattle, WA 98104

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Overview

Background

VISION 2020 is the regional growth management, economic, and transportation strategy for the Central Puget Sound Region. *Destination 2030* is the Metropolitan Transportation Plan for the region. Both of these plans attempt to match the development of a multi-modal transportation system with land use and economic objectives in the community. In planning for improved growth and vitality for the next 25 years, they provide a framework for the development of more and better public transit services to serve the region. A major step toward better transit will be the construction and operation of Sound Transit's regional high capacity transit system and its integration into the regional transportation network. The high capacity transit system investment is a critical component in the region's strategy to more efficiently move a growing population and influence long-term land use development patterns. As an integral part of the planned multi-modal transportation system, investments in high capacity transit will also contribute to the long-term economic health of the region.

Purpose and Scope of this Paper

The purpose of this paper is to describe and estimate potential economic benefits from building and operating future extensions of a regional high capacity transit system beyond what is currently approved in the *Sound Move* plan. *Sound Move* investments will generally be completed by 2010 and potential extensions to the system – as outlined in the *Regional Transit Long-Range Vision* – are assumed to be complete in 2030. Economic benefits are broadly defined to include benefits to employers, businesses, and residents that result from travel improvements, changes to the built environment, and preservation of the natural environment. The analysis does not attempt to capture or quantify all of the possible regionwide benefits that could result from the completion of a high capacity transit investment. Additionally, the public and private costs of constructing and operating a high capacity transit system are not included as part of this analysis. The scope of this paper is limited to assessing the economic influences of a select set of potential benefits of a built-out regional high capacity transit system.

Both direct and indirect economic benefits are evaluated. Direct benefits are benefits that generate new or additional economic gains to a region. Direct benefits of transit improvements result in individuals, households, and firms acting to take advantage of increased accessibility and better travel choices. The direct economic benefits that are analyzed in this report include: travel time-savings, vehicle cost savings, transit option value, and air quality benefits. Direct benefits can then lead to several types of indirect benefits, such as increased property values due to better access to land. Indirect benefits generally do not reflect new or additional economic gains to a region. Indirect benefits largely represent capitalization of direct user benefits or transfers of economic activity from one area or group to another.[1] Indirect benefits that are analyzed in this report include benefits associated with increased property values and land use changes, benefits of improved access to jobs and other critical locations, and benefits to employment, wages, and productivity. Assessing the economic influence of transportation investments is difficult because of the potential overlap of direct and indirect benefits, leading to possible double counting. That is, indirect benefits often reflect many of the same benefits that are also expressed as direct

[1] *TCRP Report 78: Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners,* Transportation Research Board, National Research Council, 2002.

benefits, albeit in a different way. The approach used in this paper is to quantify the direct benefits selected for analysis and to describe in a qualitative way the potential indirect economic benefits.

Building on Previous Studies

Previous studies have been prepared that have looked at the economic influence of various high capacity transit investment scenarios in the Puget Sound region.[2] These analyses primarily focused on determining the long-term *net* benefits (total benefits minus total costs) of proposed public transit investments. The analysis included in this paper builds on the work included in these studies, but findings are not directly comparable. Each of the previous studies analyzed different sets of high capacity transit investments and the assumptions and scope of each study have varied widely.

The economic analysis that is most directly comparable to the scope of work in this paper was prepared for Sound Transit in 1996.[3] That study found that the economic influence of *Sound Move* would result in total benefits of $265 million (1995$) for 2010. Adjusted for inflation, the total economic benefits of the 1996 study are larger than those estimated in this paper. This difference is not unexpected given that the *Sound Move* investments will likely have a more substantial immediate impact than future high capacity transit extensions. The *Sound Move* investments are focused in strong existing transit markets whereas extensions are planned in geographic areas where growth will require development that supports strong transit markets in order to more efficiently move people and goods as we grow and maximize the benefits of overall investments in transportation infrastructure. More specific references to findings in the 1996 study are included in *Appendix A* for comparative purposes.

Summary of Findings

Economic benefits associated with public transit are both complex and diverse. Public transit reduces household transportation costs, decreases travel time, increases the pool of workers and consumers for companies, and mitigates environmental problems associated with auto travel. The level of public transit is generally considered a major factor in evaluating the economic attractiveness of a large metropolitan area. In a study conducted within the 50 largest metro areas in the U.S., a significant correlation was found between the economic competitiveness of the region and the level of public transit services.[4] Based on one-on-one interviews with company executives and other senior stakeholders in the region, transportation issues rate second only to regulations/taxes as the primary constraint to doing business in the central Puget Sound region. Sixty percent of respondents listed transportation as being one of the region's top three constraints facing businesses. Transportation and transit were identified as a critical component of a viable regional economy.[5]

Regional investments in high capacity transit beyond *Sound Move* could potentially create economic benefits in the central Puget Sound region. Regional economic impact calculated for the direct benefits described in this paper ranges from approximately $250 to $400 million in

[2] See the attached bibliography (*Appendix E*) for a complete list of these studies.
[3] *An Economic Analysis of Sound Move*, Ben Porter and Associates Inc., Transportation Economics and Management, Prepared for the Central Puget Sound Regional Transit Authority, October 1996
[4] *The Economic Importance of Public Transit*, National Business Coalition, (Nov 2003)
[5] *Draft Regional Economic Strategy For The Central Puget Sound Region*: *Background Data Report on Economic Foundations and Peer Regions*, Economic Competitiveness Group, (November 2004)

2030 (in 2004 dollars). The most significant benefit would result from travel time savings (approximately $170 - $234 million) – reflecting over ½ of total benefits calculated. Travel time savings would be experienced by both users and non-users of the system. Travel demand model data estimate that total person hours per trip would be lower for transit riders as well as auto and truck users if the high capacity system were completed. The value of these time savings would result in efficiencies throughout the economy. Vehicle cost savings would also be substantial based on forecasts of 257 million fewer vehicle miles travel in the region. Transit option value and air quality benefits are more difficult to quantify and were somewhat lower due to more uncertainty regarding their calculation.

These direct economic benefits represent new or additional economic gains to the region. Direct benefits can, in turn, lead to indirect benefits that represent capitalization of user benefits or transfers of economic activity from one area or group to another. For example, an increase in the value of a property largely reflects the capitalization of the travel benefits that are largely captured within travel time savings. Although these benefits may not necessarily be additional, the transfer or redistribution of certain benefits would support regional policy objectives. Based on findings in this paper, the development of a high capacity transit system would likely have a positive influence on a number of regional transportation, growth management, and economic development objectives.

One major regional objective is to support greater concentration of land use development in centers and near transit centers. Evidence from other U.S. cities that have developed regional transit systems suggest that high capacity transit improvements can have a significant positive impact on shaping land use patterns. These land use changes occur over a long period of time and much of the potential impact occurs in close proximity to transit facilities. With public policy support for transit-oriented development and continued private-sector market demand, the Puget Sound region is positioned to capitalize on these potential land use benefits. In addition to changes in land use patterns, other related benefits could include increased business efficiency through clustering of commercial activities and reduced public sector infrastructure costs that support business activity.

High capacity transit investments would also support regional objectives associated with employment growth, diversification, and productivity. Dollars invested in the construction, operation, and maintenance of a high capacity transit project will support new transit-related jobs. Access improvements could attract new businesses and jobs near transit investments. Each of these jobs spurs additional indirect and induced jobs as income is spent and re-spent in the economy. Much of these employment gains represent a financial transfer, since many jobs would be a result of dollars being transferred from local taxpayers to public agencies. However, jobs supported by funding from outside the region in the form of federal assistance would generate new jobs that would not have been created absent the transit investment. Although federal support for New Start high capacity transit projects has been declining, the potential influx of federal funds to support the development of a high capacity transit system in the region could be substantial.

Regional Economic Gains – Direct Benefits

The direct economic benefits that are analyzed in this chapter include: 1) travel time-savings, 2) vehicle cost savings, 3) transit option value, and 4) air quality benefits. These direct benefits generally represent new or additional economic gains to the region. Direct benefits to the economy reflect efficiency gains, such as lower household costs or fewer hours devoted to travel that can be quantified and applied to other beneficial economic activities. This analysis does not attempt to quantify all direct economic benefits. For example, air quality benefits reflect a portion of potential environmental externalities that could also include water quality, noise impacts, and global warming. Where benefits are quantified a conservative approach is used. *Appendix A: Methods of Quantifying Direct Economic Benefits* describes the methodologies employed and the specific limitations of quantifying these benefits.

Direct benefits are evaluated on an annual basis for a single year (2030) and are expressed in 2004 dollars. The travel demand model data that is used in this analysis compares two scenarios a No-Action Alternative and a Long-Range Plan Alternative. These alternatives were developed and evaluated by Sound Transit as part of the update of the Regional Transit Long-Range Plan.[6] The No-Action Alternative assumes completion of all *Sound Move – Ten Year Regional System Plan* investments for light rail, commuter rail, and regional express bus. This alternative is referred to as *Sound Move* throughout this memorandum. The Long-Range Plan Alternative is based on the Sound Transit *Regional Transit Long-Range Vision* adopted in 1996 and includes additional high capacity transit investments. This alternative is referred to as *ST Vision* in this paper.

Travel demand model data from these two alternatives is used to quantify the economic benefits associated with implementing high capacity transit investments beyond what has already been approved in the *Sound Move* plan. Therefore, the benefits calculated in this section reflect the impact associated with building *future* phases of a high capacity transit network. The calculations presented in this section reflect a single year (2030) in the life of a high capacity transit investment. To get a more complete picture of long-term economic impacts, an analysis would need to be conducted that expresses the value of the system over a longer period of time. Generally a capital intensive investment of this nature should be valued over a 30 year time period or longer. A discounted cash flow analysis such as this is generally done based on net benefits – benefits net of costs. This kind of analysis should be conducted when more detailed alignments are known and sufficient cost data can be generated.

[6] *Regional Transit Long-Range Plan, Draft Supplemental Environmental Impact Statement,* Central Puget Sound Regional Transit Authority, Dec 2004.

Figure 1: Sound Move – Ten-Year Regional Transit System Plan

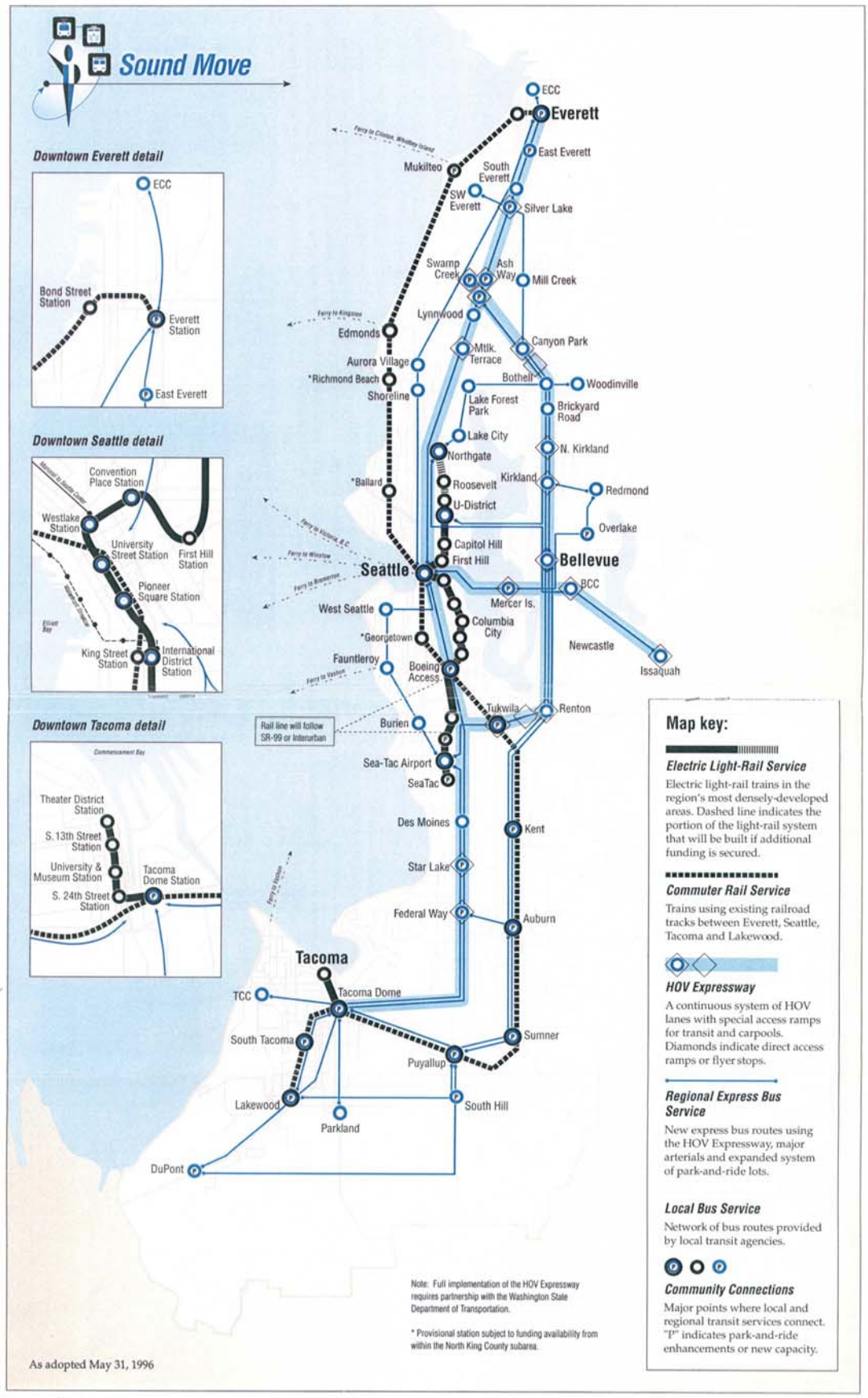
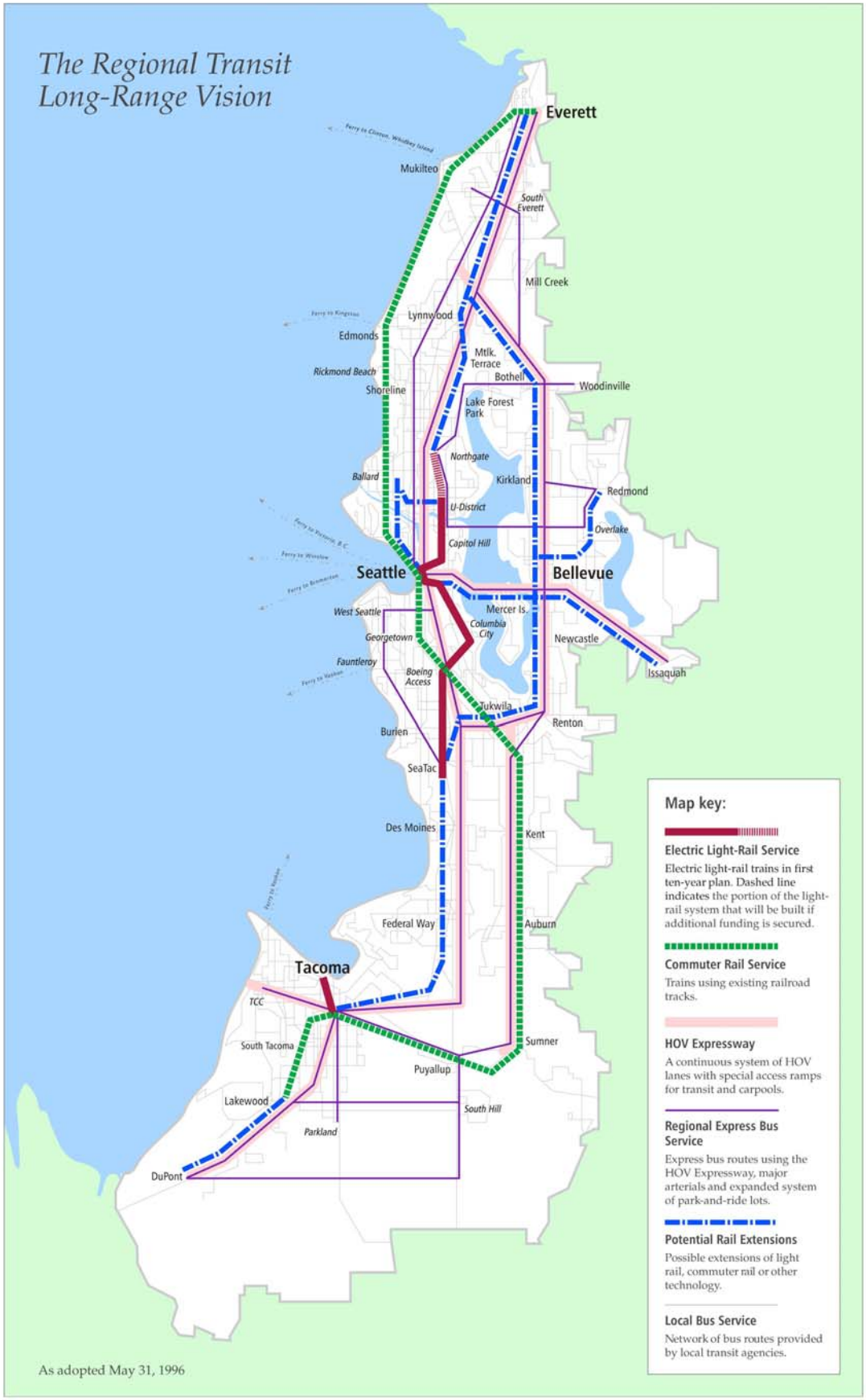


FIGURE 1.6

Figure 2: Regional Transit Long-Range Vision



Travel Time Savings

Travel time savings represent the value placed on the amount of time saved when traveling to a destination under different plan scenarios. It is assumed that time spent traveling has a cost and that this cost has a detrimental effect on the economy as this time could be spent on more productive purposes. High capacity transit improvements have the ability to reduce the time it takes to get to a destination, for both transit users and non-transit users. Transit users generally experience reduced travel times when high capacity transit utilizes dedicated rights-of-ways, expands frequencies of headways, makes limited stops, and if a significant increase in transfers or wait times do not occur. High capacity transit also has the potential to divert existing and 'would-be' drivers from roadways, thus reducing congestion or maintaining it at manageable levels thereby improving average roadway travel times[7].

There are a wide variety of methods for determining the economic value of travel time.[8] Most methods calculate the time value based on a percentage of the wage rate in the area according to the mode of travel. Trucks and commercial vehicles are given a value that is 100 percent of the wage rate to reflect the actual cost of the driver's time. Passenger vehicles are commonly given a value in the range of 40-60 percent of the prevailing average wage rate to account for the fact that travel time is not equivalent to work time. Different values are often assigned to in-vehicle travel times vs. out-of-vehicle wait times. The more complex methods incorporate influences such as congestion levels, income rates, local vs. regional travel patterns, and the level of comfort for a given trip. Additional studies separate out the modes more finely and assign a different percentage of the travel time-savings based on whether the user is a passenger or driver.

Table 1 summarizes the key travel demand model data for 2030 that are used in the travel time calculations for this analysis. Most of the travel time savings are the result of auto trip time reductions, accounting for 26.9 million fewer person hours of travel in 2030 under the *ST Vision* alternative compared with the *Sound Move* alternative. An additional reduction of 1.5 million person hours of truck or commercial travel is estimated. Forecasts show an increase of 12.9 million person hours of transit travel time in 2030 due to the significant increase in overall transit ridership. The increase in transit travel times is more than offset by the corresponding auto and truck travel time reductions. Combining the motorized modes of travel, a travel time savings of 15.6 million person hours was estimated for 2030. Based on these travel time reductions and wage rate assumptions documented in *Appendix A*, Regional Council staff calculated total annual travel time savings to be in the range of $169.4 million to $233.5 million in the year 2030 using 2004 dollars.

[7] *Diverting Auto Users to Transit: Early Lessons from CTA's Orange Line,* Market Research Department, Chicago Transit Authority, January 1997.
[8] *NCHRP Report 456: Guidebook for Assessing the Social and Economic Effects of Transportation Projects,* Transportation Research Board, National Research Council, 2001.

Table 1. Annual Travel Time (Person Hours) 2030			
***Annual Daily Person Hours**	***Sound Move*** **Ten-Year System Plan**	***ST Vision*** **Long-Range Plan**	***2030*** **Annual Travel Time Savings**
Truck	158,399,700	156,887,400	1,512,300
Auto	1,476,624,300	1,449,662,100	26,962,200
Transit	144,921,000	157,825,200	(12,904,200)
All Modes	1,779,945,000	1,764,374,700	15,570,300

*PSRC model forecast average weekday person hours multiplied by 300 (52 weeks times 5 weekdays + 0.4 times 105 weekend days).

The travel time savings calculated in this example were conservatively estimated and are likely to be somewhat understated. For example, commercial travel time could have been valued at a significantly higher rate based on current literature.[9] Assuming the higher value of time for commercial travel would add approximately $50 million in annual travel time savings to the total regional estimate. Also, if out-of-vehicle wait time were valued at a higher rate than in-vehicle wait time then the overall travel savings would be somewhat higher. *Appendix A* includes a detailed description of the assumptions used and potential limitations of this analysis.

Table 2 indicates that the individual auto traveler might experience an average savings of one minute per trip and the individual transit traveler is forecast to experience an average savings of three minutes per trip during peak hours though the wait time may increase and savings would be reduced to two minutes per trip during off-peak hours.

Table 2 Forecast Average Trip Times (Minutes) 2030				
Mode	***ST Vision*** **Long-Range System Plan**		***Sound Move*** **Ten-Year System Plan**	
	Peak	Non-Peak	Peak	Non-Peak
Transit	59	48	62	50
In-Vehicle	30	25	33	27
Wait time	29	24	29	23
Auto	24	18	25	19

PSRC/ST travel demand model forecast trip times.

The direct benefits of reduced travel time also contribute to realizing related indirect economic benefits. To the extent that the high capacity system can reduce the time it takes to get to work, for both transit users and non-transit users, the transit investment would expand access to more jobs for a greater share of the labor market. In addition, reducing roadway congestion will enhance truck and commercial vehicle travel dedicated to the delivery of goods and services. Better access to labor and improvements to commercial deliveries have a direct impact on business productivity. These and other indirect benefits that result from improved travel times are discussed in the next chapter.

Vehicle Cost Savings

Vehicle operating costs are accumulated by all motorized travel, including private, commercial and public transportation. Vehicle costs can be reduced through improved travel reliability, increased fuel efficiency, better road conditions (surface/grade), and reduced use (including potential lower ownership rates) of private vehicles. Reduced car use involves fewer maintenance needs, reduced fuel purchases, less user fees, and potentially lower insurance rates for auto users. Vehicle operating costs include fuel, oil, maintenance (tire wear/repair), capital depreciation, license and insurance, vehicle registration, and other user fees such as parking or

[9] *Case Study: Testing Applications of Integrated Transportation Planning Methods on System Level Evaluation*, ECONorthwest, prepared for the Puget Sound Regional Council and FHWA, June 1996

tolls. Vehicle cost savings can represent disposable household income that could be infused into the regional economy.

Measurements of vehicle operating costs or the value of vehicle usage are well documented. Studies attempt to estimate how many additional transit riders will be attracted to the system due to high capacity transit investments. These analyses then determine the amount of money that households could save on auto travel and estimate the impact it has on the economy. Vehicle cost savings are calculated by determining differences in VMT and applying a value for the operating cost per mile of auto travel. An operating cost value is often determined by fuel costs and maintenance needs based on average speeds in the area. The depreciation of a vehicle is another factor that is often considered.

Table 3 displays the calculated vehicle cost savings for 2030 expressed on an annual (2004$) basis. The cost savings are based on a total reduction of 257 million vehicle miles traveled between the two alternatives that were evaluated. Annual vehicle cost savings were calculated to range from $77.1 million (including vehicle ownership costs) to $126 million (including vehicle ownership and variable operating costs) in 2030 expressed in 2004 dollars. While these savings are significant, the calculated values should be considered conservative. Truck costs, which tend to be much higher than private auto costs, are not addressed separately in this analysis primarily because these estimates require data that varies dramatically according to location, market conditions, and other factors. Additionally, parking cost savings are not included in these estimates because of the difficulty in estimating them on a regional basis. See *Appendix A* for additional details regarding assumptions and limitations.

Vehicle cost savings also can spur indirect economic benefits. For example, reducing personal costs for workers could expand access to the labor pool by making travel in the region more affordable. One study found that cities with large, well established high capacity transit systems have lower overall household expenditures related to transportation – a difference of 3 percent.[10] Other benefits associated with household as well as commercial vehicle costs are addressed in the following section focused on indirect benefits.

Table 3. Annual Vehicle Cost Savings 2030 (2004$)

	Sound Move **Ten-Year System Plan**	***ST Vision*** **Long-Range System Plan**	***2030*** **Annual Vehicle Cost Savings**
VMT	31,537,090,000	31,280,013,000	257,077,000
Total Annual Vehicle Cost High ($)	$ 15,453,174,000	$ 15,327,206,000	$ 125,968,000
Total Annual Vehicle Cost Low ($)	$ 9,461,127,000	$ 9,384,004,000	$ 77,123,000

Transit Option Value

Individuals who primarily depend on the automobile may also value the availability of different travel options in certain instances. People who are typically non-transit users may value public transit because it can be a reliable alternative to auto travel when extenuating circumstances prevent or restrict auto use. Transit option value is the value a non-transit user will assign to the

[10] *Sustainability And Cities: Overcoming Automobile Dependence*, Peter Newman & Jeffrey Kenworthy, Island Press, Washington D.C., 1999.

ability to use transit as an option in the event the typical mode of travel is not available or convenient for a given trip.[11] Although transit option value can be assigned to any non-transit travel mode – walk, bike, car, carpool and vanpool – it is typically measured by the occasional demand that automobile users have for public transit. Occasional transit use may be desired for a variety of reasons, including: extreme weather conditions, severely congested roadways, vehicle maintenance and repair, high gas prices or parking costs, or short term disability or financial constraints.

Given forecasts of approximately 2.5 million one-way a.m. person trips in 2030, the annual transit option value under the *Sound Move* alternative and under the *ST Vision* alternative were estimated. *Appendix A* describes the assumptions, methods, and limitations of this analysis in more detail. The annual option value was calculated to be within the range of $279,000 to $500,000 in 2030 expressed in 2004 dollars. The calculations conducted as part of this analysis rely on assumptions regarding whether an individual is likely to choose transit instead of an automobile for a limited number of trips each year. The average cost of an auto trip and a transit trip are relatively easy to estimate with some accuracy. On the other hand, the volatility of auto trip costs and estimating the number of times an auto user might need to use transit are much more difficult and can vary widely. Due to these uncertainties, conservative assumptions were used and the estimated annual option value could significantly understate actual benefits.

Air Quality Benefits

An effective transit improvement can provide environmental benefits, primarily from a decrease in automobile use and the resulting reductions in air pollution, water pollution, and noise associated with that travel mode. Often these environmental costs or benefits are not considered by travelers in everyday decisions about whether to drive or ride transit. Air quality impacts are most often identified as the major source of region-wide benefits resulting from investments in public transit. Noise and water quality impacts are generally less significant and are more difficult to address at the regional level because impacts are more localized. As a result, the focus of this analysis is on quantifying the value in reducing region-wide air quality impacts.

Air pollutants of principal concern for transportation projects include carbon monoxide (CO) and particulate matter smaller than 10 microns in diameter (PM10)—pollutants that are emitted from vehicular tailpipes. Nitrogen oxides (NOx) and volatile organic compounds (VOCs) are also released from transportation sources and are of concern as precursors in the formation of ozone in the atmosphere. Diesel-fueled vehicles also emit sulfur oxides (SOx). These pollutants can contribute to a wide variety of negative health problems, including respiratory illness and lung damage. Elevated ozone levels can cause damage to plants, trees, and crops. Although transit projects generally result in a regional air quality benefit, adverse impacts could result from increased traffic volumes near transit stations, or increased use of diesel fueled vehicles.[12]

This analysis quantifies air quality impacts primarily as a function of the difference in vehicle miles traveled between the two plan alternatives. The travel demand model forecasts that in 2030 there will be 257 million fewer vehicle miles traveled under the *ST Vision* than the *Sound Move* alternative, primarily due to an increased share of public transit travel. The annual air quality savings is calculated to be within the range of $2.6 million to $30.4 million in 2030 expressed in

[11] *TCRP Report 78*
[12] *TCRP Report 35: Economic Impact Analysis of Transit Investments: Guidebook for Practitioners*, Robert Cervero and David Aschauer, Cambridge Systematics, Inc., Transit Cooperative Research Program (Washington, D.C.: National Academy Press, 1998).

2004 dollars. This wide range in potential air quality benefits is a result of the variation in cost information available for estimating the value of pollutants per kilogram of output. These ranges represent the wide variation in how researchers have valued the impacts associated with these pollutants. *Appendix A* provides additional details.

Reducing environmental impacts related to auto travel is essential in sustaining the high quality of life in the region. However, the indirect economic benefits associated with better environmental quality are difficult to quantify. Environmental quality could potentially help in attracting workers and business to the region. The existence of a high capacity transit system has been used to market other regions as places that invest in progressive, environmentally sound, and technologically advanced mobility alternatives in order to attract expertise from a variety of fields such as life sciences and information technology.[13] These indirect economic benefits are discussed in the next section.

[13] *The Benefits of Public Transportation: An Overview*, Reichman Frankle, Inc. American Public Transportation Association, 2002.

Capitalization of Economic Benefits – Indirect Benefits

The direct economic benefits analyzed in the previous chapter generally represent new or additional economic gains to the region. These direct benefits, in turn, can then lead to several types of indirect benefits, representing capitalization of direct user benefits or transfers of economic activity from one area or group to another. Because direct and indirect benefits can reflect some of the same benefits in different ways they generally should not be added together. For example, an increase in the value of a property largely reflects the capitalization of the travel benefits that are largely captured within travel time savings. Households and firms that shift their location decisions based on transit investments due to improved access may come at the expense of locations not served as well by transit. Although these benefits may not technically be additional, the redistribution of land use value and other indirect benefits discussed here may represent ancillary benefits if it helps to achieve regional policy objectives.

It should also be noted that not all of the impacts associated with indirect benefits are captured under the assessment of direct benefits. For example, additional benefits could result from increased property values and land use change as a result of agglomerative economies, also called economies of clustering or proximity.[14] Such clustering of commercial activity may allow exploitation of scale economies, such as reduced labor cost, better communication, and increased interaction with similar businesses. Additional economic benefits, not fully accounted for under direct benefits, could also result from improved transit access when travel benefits extend to residents or business that are particularly underserved. These benefits result from transit investments that successfully address transportation gaps to employment opportunities or when transit-dependent populations are provided with significantly better access to critical services.

Indirect benefits that are analyzed in this section include benefits associated with increased property values and land use changes, benefits of improved access to jobs for certain population segments, and benefits to employment, wages, and productivity. The qualitative assessment of these benefits attempts to identify whether new economic gains are generated and/or where benefits represent a redistribution or financial transfer. Evidence from national studies is provided to support potential implications for the central Puget Sound region.

Property Values and Land Development Changes

Regional transit investments can improve the accessibility to geographic locations by reducing the cost, measured in time or dollars, of traveling to these locations. An increased level of accessibility can make properties more desirable, which is reflected in higher sales or rental values. These increased values in property, in turn, can influence the type of development that occurs. Short-term construction impacts can be negative, including barriers to access, loss of parking, and noise. In the long-term, however, improved accessibility along transit corridors generally results in positive impacts to property values and on land use development.[15]

Although these benefits largely reflect a redistribution of land use development activity within a region, they can represent ancillary benefits if it helps to achieve regional policy objectives. In addition, increased property values and land use change can result in the creation of agglomerative economies. Such clustering of commercial activity help to increase economic

[14] *TCRP Report 35*

[15] *TCRP Report 16: Transit, Urban Form and the Built Environment: A Summary of Knowledge.* Parsons, Brinkerhoff Quade and Douglas, Inc.; *(Vol. 1 Part 1& Vol. 2 Part 2),* 1996.

efficiency by keeping infrastructure costs down or expanding interaction with similar businesses. Agglomeration benefits are discussed again as they relate to employment and economic productivity.

Of course, there are other factors besides transportation accessibility that influence property values and land use development decisions. Two other factors often cited as major influences on land use are: 1) public-sector support for development and 2) private-sector market trends. Public policies influence the supply of land available for development and directly affect the cost of development. These public policies include zoning, environmental regulations, and the provision of water, sewer, and other infrastructure. Local real estate and business market conditions must also be favorable to support positive land use changes. Land use effects associated with transit investments are therefore most pronounced in fast growing markets and where public policies support development change.[16]

Findings from National Studies

There have been a significant number of reports written on the effects transit can have on property values and land use development (Cervero, Seskin, Kentworthy, and others). Many of the studies focus on the number of projects that have been built within a quarter-mile or half-mile of an existing fixed-route rail transit system. Some of the indicators that are used include rental rates, occupancy rates, the amount of vacant land, and assessed land and property values. Surveys of business owners, residents, and real estate brokers are also used in order to evaluate whether a system has had an influence on development patterns.

Studies suggest that, as transportation costs fall and access is improved, incentives are created for households and firms to relocate to areas where housing and land is less expensive or more desirable. This can result in new development and increases in land values of the areas made more accessible. At the same time, it can result in land values falling in other locations, due to changes in relative access, and negative impacts from noise and emissions that may result from the improvement. Several studies have documented that increases in land values and higher-density development can occur around high capacity transit stations, although these impacts depend highly on local conditions, such as the condition of the local economy, and the extent to which complimentary land-use policies exist.[17] See *Appendix B* for a summary of the studies focused on property value increases near transit investments.

Findings of studies conducted throughout the U.S. are summarized below.[18]

- Travel responses to transit system investments (e.g., increased ridership) are seen much more quickly than land use responses. Studies suggest that positive effects on property values and land use development may not appear for more than a decade after completion of the transit system.

- Studies show that positive impacts on property values are most pronounced in areas within ½ to ¼ mile radius of high capacity transit stations. Surveys indicate that the private-sector focuses on transit station areas (within ½ mile of a station) for major land use development markets.

[16] *TCRP Report 16 Vol. 1*
[17] *Estimating the Benefits and Costs of Public Transit Projects*, ECONorthwest and Parsons Brinckerhoff Quade & Douglas, Inc. (1999)
[18] *TCRP Report 16 Vol. 1*

- In general, greater impact will occur where densities are higher, travel-time savings are large, transit stations coexist with other transportation junctions such as highways, and regions are experiencing a high degree of population and employment growth. Large investments in high capacity transit that offer significant accessibility benefits are more likely to have large land use impacts.

- For most types of transportation investments (i.e., highways and transit) the associated benefits are more likely to redistribute land use development activity within the region, rather than generate new or additional economic growth. High capacity transit's impact on land use is generally more localized than impacts resulting from highway improvements.

- There is strong evidence that more permanent high capacity transit systems (i.e., fixed-route rail and other capital intensive investments) have a significantly greater influence on property values and rising rents. The development community also responds more quickly to these investments.

- Studies indicate that there is more of an influence on commercial and industrial uses rather than the assessed value of residential property. However, research also indicates that there is a stronger correlation between high capacity system development and rising residential property values in low-income areas than in high-income areas.

- As land values and development activity increase, roadway congestion in the vicinity of high capacity transit investments will also worsen. The existence of the regional transit investment can mitigate the impacts associated with these density and congestion increases, but improvements to the local transportation system may also be needed.

Implications in the Puget Sound Region

The central Puget Sound region appears to be uniquely positioned to capitalize on the potential long-term benefits of land use development and property values. In addition to the investment in high capacity transit, the region has public-sector support for transit-related development and a strong private-sector market demand is forecast. VISION 2020 calls for higher-density, pedestrian-focused development in centers. Local governments throughout the region have developed transit-supportive land use plans and adopted regulations that implement the regional vision. In addition, long-range economic forecasts indicate strong employment growth, increasing personal income and wages, and additional population increases in the region.[19]

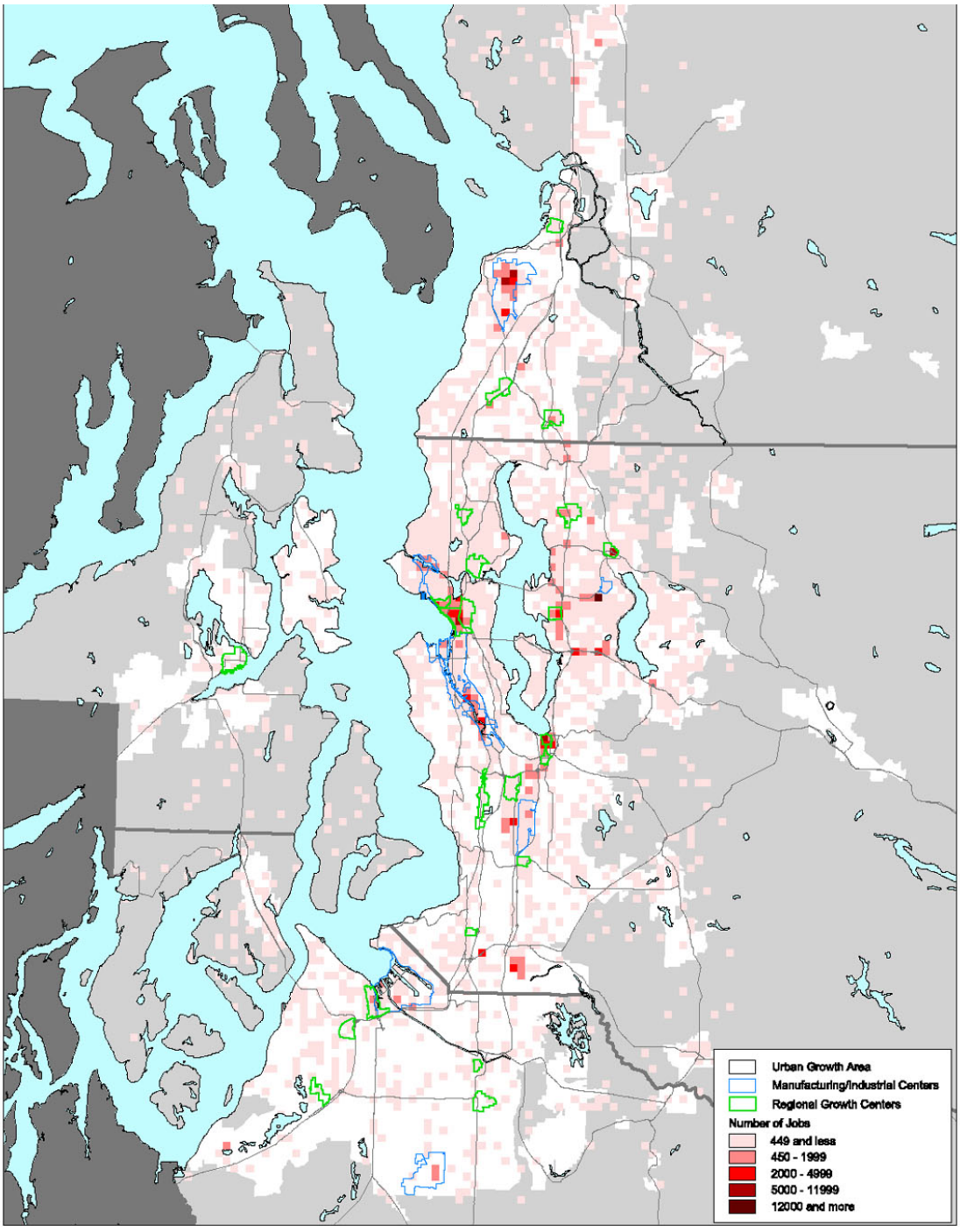
A central regional policy objective is to concentrate more development activity in designated urban growth areas and preserve the character of rural lands and resource areas. The identification and designation of regional growth centers is a major focus of the growth management strategy. These regional growth centers are planned to support much of the future employment growth and additional household growth as well. In addition, the regional growth strategy also identifies manufacturing/ industrial centers that are planned locations for employment growth. Approximately 30 percent of all jobs are currently located in these regionally designated centers, and a higher percentage is expected by 2020 if current plans are realized.[20] Public transit will play an increasingly larger role in supporting the additional growth

[19] *Draft Regional Economic Strategy For The Central Puget Sound Region*, Puget Sound Regional Council and Economic Competitiveness Group, May 2005

[20] *Puget Sound Milestones: Central Puget Sound Regional Growth Centers Report*, Puget Sound Regional Council, (December 2002).

that is forecast in these growth centers. The Sound Transit *Vision* is largely based on serving and connecting regionally-designated centers. Most centers would be served directly by high capacity transit investments, including light rail, commuter rail, express bus or a combination of these transit technologies. High capacity transit could play a critical role in the expanding the competitiveness of regional centers, including the provision of affordable housing opportunities, job growth, and additional commercial retail development. Additional benefits could arise, when the clustering of business activity creates scale economies or if infrastructure cost savings result from compact development patterns. Although the bulk of the land use impacts would likely result in a redistribution of land value and development, it would still represent a substantial benefit to the central Puget Sound region and would play a significant role in achieving the region's growth management strategy.

Figure 3: Industrial Cluster Employment & Designated Regional Centers, 2001



Access To Jobs and Other Critical Locations

An important element of economic development is the ability to bridge gaps and form connections between different environments and people, contributing to additional choices in terms of travel, housing, education, and employment. A high capacity transit system can potentially expand access to employment opportunities to a greater share of the region's population. This is especially true when a mismatch exists between an employer's need for labor with certain skills and the locations where labor with those skills exists. The regional economy benefits as people are able to access additional employers and businesses benefit from the ability to attract more potential workers. In addition, a lack of transportation choices can severely limit or restrict entirely the personal and economic opportunities available to people who cannot depend on the automobile due to age, disability, income or other reasons. High capacity transit provides economic benefits by providing accessibility to jobs, medical centers, retail stores, and other destinations for transit-dependent populations.

Investments in high capacity transit can result in significantly better access to a greater share of the population and to a wider range of destinations. Much of these accessibility benefits are captured as direct user benefits, such as reduced travel times or vehicle cost savings. Additional benefits, however, could also result from improved transit access when travel benefits extend to residents or business that are underserved or depend more heavily on transit access. These additional benefits are generated as a result of transit investments that successfully address transportation gaps to employment opportunities and/or when transit-dependent populations are provided with significantly better access to other critical services. These benefits could result in a wide range of savings, from social interaction to welfare programs.

Findings from National Studies
Increased employment opportunities have been estimated as a result of transit alleviating the spatial mismatch of jobs and workers. Studies have been done to demonstrate the capacity of a transit system to facilitate mobility between where workers reside and the location of specific employment opportunities. Surveys of transit riders have been used to determine the number of persons using the system to travel to work who otherwise would not be able to do so without the system.

Some findings from national studies include:

- Transit projects that connect an area of high unemployment to an area with very low unemployment will produce the greatest effects on the regional economy. Also, large metropolitan areas experience the greatest impact, in part because of the potential for the largest disparity of unemployment variances within the region.[21]

- Research supports the concept that better transit access results in lower household transportation costs. This money is then available for other discretionary household spending. Operating cost per transit trip has been found to be 2 to 3 times less than by car.[22]

[21] TCRP Report 78
[22] *Transit Means Business – The Economic Case For Public Transit in Canada,* (Executive Summary), Canadian Urban Transit Association, 2003.

- Because visitors to a region/city often do not have access to a car, transit is often cited as a benefit to tourism. This can be especially true of a fixed-route high capacity system that may be easier to understand and navigate. Also, tourism related employees are generally more dependent on transit than other types of employment.[23]

- Enhanced accessibility leads to the ability for employers to attract labor from communities where residents find it difficult to afford an automobile or inconvenient to use existing transit in their effort to locate in areas with more affordable housing.[24]

Implications for the Puget Sound Region

A fully built out high capacity transit system will have a significant beneficial impact on access to jobs and other important locations throughout the region. In addition to the overall travel time benefits that a high capacity transit system can provide, other indirect benefits associated with regional accessibility could also be realized. Much of these indirect accessibility benefits would result from addressing any potential mismatch between labor markets and employers and/or introducing significantly better service to transit-dependent populations.

An expanded high capacity transit service in the region could be expected to improve connections for unemployed or underemployed persons living or working in close proximity to new transit services. Improved transit access would allow some residents to reach jobs and achieve gainful employment that they might not otherwise have access to. This would reduce unemployment and could represent a welfare gain not only to the individual but also to society at large. For example, an expanded high capacity transit service could give workers in the central city of Seattle greater access to the employment opportunities in many of the growing suburban growth centers.

As discussed previously, at full build-out the high capacity transit system is planned to directly serve most of the regionally-designated growth centers. These centers (both regional growth centers and manufacturing/ industrial centers) are being planned to accommodate a large share of the forecasted employment growth over the next 25-30 years. This high capacity transit investment can be expected to substantially increase access to more jobs for more people in the region. Some of the improved access to jobs will be the result of diminishing any mis-match between workers and employers. Other job opportunities could become available to transit-dependent populations. In Sound Transit's Environmental Justice analysis, high capacity transit investments were found to have a positive influence on geographic areas with large low-income and minority populations.[25]

Currently, about 7 percent of people in the region use transit to get to work, and by 2030 transit mode-share is forecast to reach over 12 percent.[26] Increasingly, employers are making the connection between transit accessibility and viability of their operations. Manufacturing facilities, telemarketing firms, and recreational businesses, in particular, depend on transit to deliver workers.[27]

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[23] TCRP Report 35
[24] TCRP Report 78
[25] *Regional Transit Long-Range Plan, Draft Supplemental Environmental Impact Statement,* Central Puget Sound Regional Transit Authority, Dec 2004.
[26] *Destination 2030: Technical Appendix,* Puget Sound Regional Council, 2001.
[27] *Draft Regional Economic Strategy For The Central Puget Sound Region,* Puget Sound Regional Council and Economic Competitiveness Group, May 2005

Employment, Wages and Productivity

Transportation improvements can lead to increased productivity and economic growth by improving access to goods and services, increasing the geographic size of potential labor pools for employers and the number of potential jobs for individuals. Transit can also lead to economic growth by encouraging the concentration of economic activity and the clustering of offices, shops, entertainment centers, and other land uses around transit stops, particularly high capacity transit stations. The clustering of these uses can produce economic benefits in a number of ways. Agglomeration benefits reflect the higher productivity, creativity, and synergy associated with increased face-to-face contact, access to specialized labor, and external transactions made possible by more compact, transit-served development. Related impacts are urbanization benefits – the reduced outlay for urban infrastructure, such as water lines and sanitation facilities, that result from the more compact patterns of development that transit service makes possible.

Many of these benefits represent a redistribution of advantages rather than entirely new benefits. Just as a transit investment can redistribute land development to a corridor, it also can shift jobs to a transit corridor. Existing firms may move from elsewhere in the region, or firms that were going to locate within the region anyway may choose to locate near transit stations. This redistribution of employment can produce income growth in the corridor. However, a corresponding reduction in employment and income could likely occur elsewhere in the region, facilitating the need to phase in the system over time and mitigate for relocation costs to businesses and impacts communities further from the system. The benefits of high capacity transit can also generate additional benefits if new businesses are attracted to a region as a direct result of the improved transportation system.[28] For example, reduced travel times in a region that result from improved transit services may induce growth by attracting new firms and workers to a region. This in turn can attract new companies and investments to a region by giving local firms a competitive advantage and making a region a more attractive place for labor to locate.

Findings from National Studies

A variety of techniques are used to measure different types of economic development impacts, including transportation-land use models, benefit-cost analysis, input-output models, economic forecasting models, econometric models, case studies, surveys, real estate market analysis and fiscal impact analysis (Cambridge Systematics, 1998; Lewis and Williams, 1999; Weisbrod, 2000; and HLB 2002; Leigh, Scott & Cleary, 1999).

Among some of the findings based on studies conducted in the U.S., examples include:

- Because transit is labor intensive, transit expenditures tend to provide more permanent jobs and local business activity than most other transportation investments. One study found estimated that a million dollars spent on public transit typically generates 30-60 jobs. Another report claims that a typical set of transit investments creates 19 percent more jobs than the same amount spent on a typical set of road and bridge projects.[29]

- Residents of cities with quality transit systems tend to spend less on transportation overall. Residents of cities with large, well-established high capacity transit systems spend an average 12 percent of their total household expenditures on transportation

[28] *Economic Analysis Primer*, U.S Department of Transportation, FHWA Office of Asset Management, August 2003.

[29] *Estimating the Benefits and Costs of Public Transit Projects*, ECONorthwest and Parsons Brinckerhoff Quade & Douglas, Inc. (1999)

compared with 15 percent in cities that lack high capacity transit options.[30] These savings are offset by the fact that transit systems are generally subsidized by taxpayers.

- The concentration of land use activity leads to more efficient economic interactions, which results in higher productivity and can stimulate economic growth. One study estimated that the rate of return of several investments in new transit capacity suggests that these returns vary dramatically depending on the project, with projects ranging from 11.8 percent returns to 92 percent returns.[31]

- As the nation's economy shifts from a heavy manufacturing base to a more service-oriented economy, transit's direct productivity benefits may become more substantial. Transit, for instance, may reduce the input costs of office-related businesses by facilitating more face-to-face interactions by speeding business-related intra-metropolitan travel.[32]

Implications for the Puget Sound Region

The development of a high capacity transit system has the potential to address many issues related to access to markets, infrastructure, housing, planning for growth, education and workforce development. A high capacity transit system has the potential to support the regional growth strategy and maintain or enhance the quality of the region's neighborhoods and expand productivity by targeting growth near transit corridors. This is primarily accomplished through enhanced accessibility, but transit also has the potential to be one of many catalysts for development as developers choose to locate in the vicinity of public investments in transit stations.

A high capacity transit system has the potential to help fulfill some of these goals by maintaining or at least mitigating some of the congestion that is to occur over the next 20-30 years. It can serve both as a capacity expansion tool and a demand or congestion management tool. The development of a built-out high capacity transit system results in a reduced level of vehicle miles traveled and person hours dedicated to travel time compared to a non-built out system. This indicates that roadways are less congested than they might otherwise have been if the system had not been built.

The Puget Sound Regional Council is currently developing a Regional Economic Strategy (RES) to better inform the implementation of economic policies contained in VISION 2020. A coalition made up of government, business and community leaders from throughout the central Puget Sound region has been organized to collaborate on a unified economic agenda for the region. This coalition – called the *Prosperity Partnership* — will identify the actions the region can take to improve its attractiveness to enterprise and create good jobs. The *Prosperity Partnership* has identified public transportation as a critical component of a viable regional economy and a necessary component of the region's overall competitiveness.

An initial focus of the *Prosperity Partnership* has been to identify action strategies that support specific clusters of industries. The competitive advantage of a location does not usually arise in isolated companies but in clusters of companies – companies that are the same industry or

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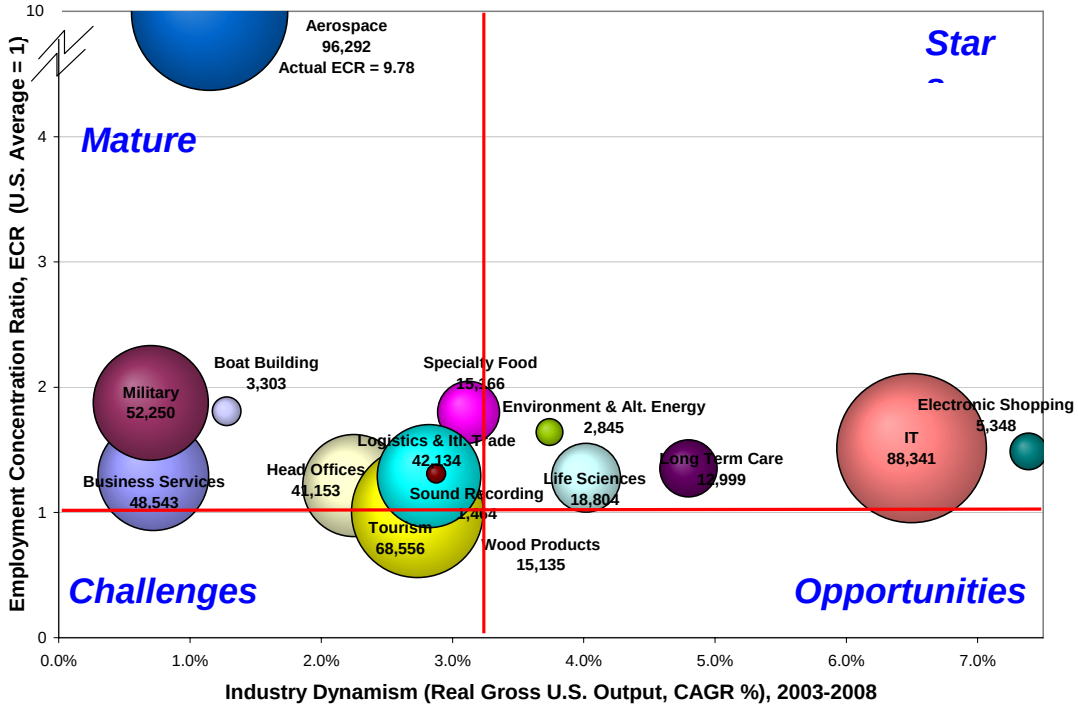
[30] *Sustainability And Cities: Overcoming Automobile Dependence*, Peter Newman & Jeffrey Kenworthy, Island Press, Washington D.C., 1999.
[31] *Transit Benefits 2000 Working Papers: A Public Choice Policy Analysis*, Office of Policy Development, Federal Transit Administration, U.S. Department of Transportation, (Washington, D.C.: 2000).
[32] *TCRP Report 35, TRB, 1998*

otherwise linked together through customer, supplier or similar relationships. Clusters represent critical masses of skill, information, relationships, and infrastructure in a given field. Analysis as part of the Regional Economic Strategy has identified more than a dozen clusters in the central Puget Sound region, in varying degrees of maturity and performance. The identified clusters are more heavily concentrated in the Puget Sound than in typical metro regions.[33]

Figure 4: Array of Industry Clusters In The Puget Sound Region



Source: Global Insight Inc., 2005

The development of a high capacity transit system is likely to benefit different industry types in varying ways, particularly from increased linkages between different aspects of business, government, and community services. Economically significant linkages do exist between businesses in the region, other organizations, government agencies, and workforce training institutions. Transit supports these linkages by providing additional access to labor, networking opportunities and, to a limited extent, suppliers. Transit opens up opportunities that the different clusters can capitalize upon.

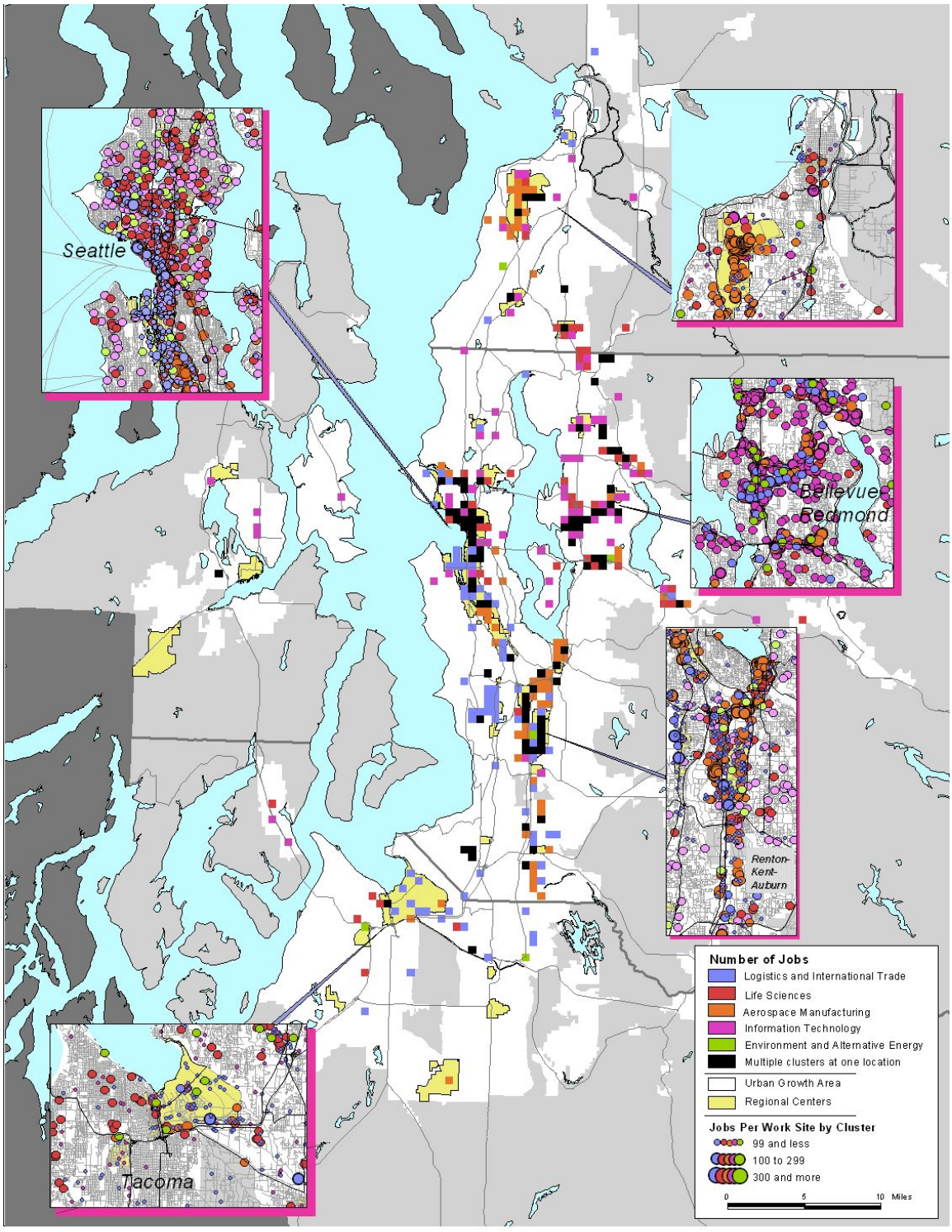
Job concentrations near stations along the proposed high capacity transit system may have some benefits to individual clusters. Strong market accessibility is an important feature for any economy that requires connections that span across a wide geographic area in order to provide discourse between different individuals and additional routes for supplying products internally and externally between workers, offices, storage facilities, and sales locations. The community benefits as people in the region are able to access additional employers that were either previously unavailable or inconvenient to reach due to historical land use patterns with long

[33] *Draft Regional Economic Strategy For The Central Puget Sound Region*, Puget Sound Regional Council & Economic Competitiveness Group, May 2005

distances between home and work. Businesses benefit from the ability to attract workers from more areas.

A rough, initial look at the clusters demonstrates that a high percentage of jobs and business concentrations for each industry type are in proximity to the proposed high capacity transit system investments. Once the location of stations has been determined, additional analysis will be needed to identify the clusters that can capitalize on the proposed system by enhancing an employer's level of access to a more diversified work force and an employee's level of access to jobs within more diverse job types from each cluster.

Figure 5: Spatial Attributes of Pilot Clusters, 2002



Appendix A: Methods of Quantifying Direct Economic Benefits

This appendix represents identifies methods for estimating selected direct economic benefits that would result from the development of a regional high capacity transit system in the central Puget Sound region. These 'direct' benefits can be realized by both users and non-users of the high capacity transit system.

The direct economic benefits that were evaluated include:

1) Travel time savings
2) Vehicle cost savings
3) Transit option value
4) Air Quality benefits

Various evaluation methods are described to measure these benefits based on the case studies documented in Appendix A and the bibliography in Appendix C. Travel demand model runs were conducted to compile data that isolates the transportation impacts associated with build-out of the Regional Transit Long-Range Vision. The benefits that were selected are evaluated on an annual basis for a single year (2030) and are expressed in 2004 dollars. The travel demand model data that is used in this analysis compares two scenarios a No-Action Alternative and a Long-Range Plan Alternative. These alternatives were developed and evaluated by Sound Transit in the recently released Draft Supplemental Environmental Impact Statement (SEIS) as part of the update of the Regional Transit Long-Range Plan (December 2004). The No-Action Alternative assumes completion of all *Sound Move – Ten Year System Plan* investments for light rail, commuter rail, and regional express bus. This alternative is referred to as *Sound Move* throughout this memorandum. The Long-Range Plan Alternative is based on the Sound Transit *Regional Transit Long-Range Vision* adopted in 1996 and includes additional high capacity transit investments. This alternative is referred to as *ST Vision* in this memo. Using travel data from these two alternatives allows us to quantify the economic benefits associated with implementing high capacity transit investments beyond what has already been approved in the *Sound Move* plan.

The primary sources consulted and referenced throughout this memo include reports prepared by the National Cooperative Highway Research Program (NCHRP) [34], Transit Cooperative Research Program (TCRP) [35] and Victoria Transport Policy Institute (VTPI).[36]

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[34] -*NCHRP Report 456: Guidebook for Assessing the Social and Economic Effects of Transportation Projects*, Transportation Research Board, National Research Council, 2001.
- *NCHRP Report 342: Primer on Transportation, Productivity, and Economic Development*, Transportation Research Board, National Research Council, 1991.

[35] - *TCRP Report 78: Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners*, Transportation Research Board, National Research Council, 2002.
- *TCRP Report 35: Economic Impact Analysis of Transit Investments: Guidebook for Practitioners*, Robert Cervero and David Aschauer, Cambridge Systematics, Inc., Transit Cooperative Research Program (Washington, D.C.: National Academy Press, 1998).

[36] -*Evaluating Transit Benefits and Costs*, Todd Litman, Victoria Transport Policy Institute, July 23, 2004.
-*Comprehensive Evaluation of Rail Transit Benefits*, Todd Litman, Victoria Transport Policy Institute, May 12, 2004.

Travel Time Savings

1.1 Sources and Methods

A number of national publications evaluate transit's travel time savings and other indirect results of improved travel efficiencies. Methods used to determine the economic value of travel time generally calculate the value of time based on a percentage of the wage rate in the area varying by mode of travel. Trucks and commercial vehicles are generally given a value that is 100 percent or more of the wage rate because they are considered "on-the-clock". Commercial travel time commonly includes the value of driver wages and benefits, but could also address the level of sensitivity to time for shipped goods and other employer overhead costs.

Passenger vehicles are commonly given a value in the range of 40-60 percent of the prevailing average wage rate. A 1992 study by the Federal Highway Administration (FHWA) found that the average value of time used in multiple studies was 50 percent of the gross wage rate.[37] Different percents of wage rates can be assigned to in-vehicle travel times vs. out-of-vehicle wait times. The more complex methods incorporate influences such as; congestion levels, income rates, local and regional travel patterns, and the level of comfort for a given trip. Other methods assign a different percentage of travel time savings based on whether the traveler is a passenger or a driver. A lower value of time can be assigned to passengers (transit and auto) because their time can be productively used during travel.

For this study, Regional Council staff evaluated the impact of reduced travel time by using a value based on the prevailing wage rate in the region for fiscal year 2003 developed for the *Benefit-Cost Analysis Methodology Technical Memorandum* by WSDOT in their Congestion Relief Analysis (CRA) Project. This work estimated the average wage rate to be $22.50 per hour in 2003 dollars for the four county region.[38] The Regional Council adjusted this number to reflect current year (2004) dollar values. Regional travel demand model data was used to estimate person hours of travel by trip type, broken down by truck, transit, and auto. The person hours of travel for each trip type were multiplied by a corresponding wage rate. Consistent with the CRA, person hours dedicated to truck travel were given a dollar value of 120 percent of the wage rate to account for driver wages and benefits. To establish a range, values of 40 percent and 60 percent of the wage rate were assigned for auto and transit person hours. Using two wage rates (high/low) accounts for variations in the value auto users (passengers and drivers) and transit users place on travel time and is consistent with other studies.

1.2 Results

As mentioned, the primary variables considered in the analysis of travel time are person hours of travel and wage rates. Auto person hours were calculated by multiplying vehicle hours by the occupancy rates based on the mix of single-occupant vehicles, carpools, and vanpools forecast in 2030. Truck person hours were calculated assuming that each light, medium, or heavy vehicle contained one driver. For transit person hours, access time, total wait time, boarding, and in-vehicle time were summed for both walk and auto access to transit services. Total travel time includes both off-peak person hours and peak person hours on an annual basis. The average hourly wage rate is estimated to be $22.78 per hour in the region based on the adjusted CRA

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[37] *Metropolitan Planning Technical Report, Evaluation of Transportation Alternatives*, U.S. Department of Transportation, Federal Highway Administration, September 1995. Report draws from conclusions from *Urban Transportation Economics*, Vol. 51, Kenneth A. Small, 1992.

[38] *Benefit-Cost Analysis Methodology: Technical Memorandum*, Parsons Brinkerhoff, 2004 (Page 25). Prepared for *Congestion Relief Analysis Project*, WSDOT, July 2004.

estimate. Given the identified assumptions, an average value of one hour of $27.34 (120 percent) was assigned to truck travel and values of $9.11 (40 percent) and $13.67 (60 percent) were calculated to establish a range for auto and transit travel time savings.

Table A-1 summarizes the key travel demand model data for 2030 that are used in the travel time calculations.

Table A-1 Annual Travel Time (Person Hours) 2030

***Annual Daily Person Hours**	***Sound Move*** **Ten-Year System Plan**	***ST Vision*** **Long-Range Plan**	***2030*** **Annual Travel Time Savings**
Truck	158,399,700	156,887,400	1,512,300
Auto	1,476,624,300	1,449,662,100	26,962,200
Transit	144,921,000	157,825,200	(12,904,200)
All Modes	1,779,945,000	1,764,374,700	15,570,300

*PSRC model forecast average weekday person hours multiplied by 300 (52 weeks times 5 weekdays + 0.4 times 105 weekend days).

The literature search revealed a number of sources where commercial vehicle trips were valued at a higher rate than the value used in this analysis. For example, in a study prepared for the Puget Sound Regional Council and FHWA, ECONorthwest used a separate wage rate for trucks – $60 per hour in 1995$ – that included the sensitivity to time for shipped goods and other employer overhead costs in addition to driver wages and benefits.[39]

Table A-2 Forecast Average Trip Times (Minutes) 2030

Mode	***ST Vision*** **Long-Range System Plan**		***Sound Move*** **Ten-Year System Plan**	
	Peak	Non-Peak	Peak	Non-Peak
Transit	59	48	62	50
In-Vehicle	30	25	33	27
Wait time	29	24	29	23
Auto	24	18	25	19

PSRC/ST travel demand model forecast trip times.

For greater precision, different values can be assigned to in-vehicle versus out-of-vehicle time for transit travel and to vehicle driver person hours versus vehicle passenger time for auto travel. Vehicle travel time is generally valued at a lower rate than out-of-vehicle wait time. As shown on *Table A-2*, nearly 50 percent of the total transit travel time is made up of out-of-vehicle wait time compared to in-vehicle travel time. If out-of-vehicle wait time is valued at a higher rate for transit trips – some studies suggest as high as 100 percent – then the overall travel savings would be higher.

For comparison purposes, the *Economic Analysis of Sound Move (1996)* estimated travel time savings to be approximately $188 million in 2010 (1995$) based on *Sound Move* implementation compared to a no-build alternative.[40] This previous estimate calculates the benefits of an entirely different set of investments and is based on different wage rate assumptions. The difference between the estimates is reasonable and should be expected but helps provide some perspective on the Regional Council estimate.

[39] *Case Study: Testing Applications of Integrated Transportation Planning Methods on System Level Evaluation,* ECONorthwest, prepared for the Puget Sound Regional Council and FHWA, June 1996.
[40] *An Economic Analysis of Sound Move,* Ben Porter and Associates Inc., Transportation Economics and Management, Prepared for the Central Puget Sound Regional Transit Authority, October 1996

Vehicle Cost Savings

2.1 Sources and Methods

A common method of quantifying vehicle operating savings is to estimate differences in vehicle miles traveled (VMT) between two or more alternatives and apply a value for the vehicle cost per mile of travel. Attempts to monetize the vehicle use per mile of travel can vary widely depending on the costs that are included and the assumptions made. The range of reported vehicle costs per mile include: Bureau of Labor Statistics at $0.25 per mile, VTPI report at $0.78 per mile, the American Automobile Association (AAA) at $0.56 per mile, and the Internal Revenue Service at $0.41 per mile.

For greater precision, costs can be evaluated based on trip type (linked and unlinked trips), trip times (peak vs. off-peak), and trip distance. Values can be assigned based on incidents, fatalities, injuries, property damage, policing, and emergency services. A shift from automobile travel to transit travel can also be expected to reduce parking costs. Lower vehicle ownership rates reduce residential parking demand and fewer vehicle trips reduce non-residential parking demand, such as commercial or worksite parking. This benefit can manifest itself as a user cost savings where parking is priced and also result in reduced parking congestion and increased convenience to motorists. Reduced parking demand can also lower investments in parking facilities for businesses and eliminate the need to devote valuable land to its use.

The Regional Council uses an approach that is consistent with methods described in the NCHRP and TCRP reports. The difference in total daily vehicle miles traveled in 2030 was calculated between the *Sound Move* alternative and the *ST Vision*. The vehicle cost per mile of travel was determined based on estimates used in the Congestion Relief Analysis (CRA) conducted by WSDOT in 2004. The CRA project generated updated vehicle cost information based on local conditions. For our analysis, two estimates where used that express the range of value that can be applied to vehicle costs. The low value ($0.30 per mile) is based on fixed vehicle ownership costs such as insurance, license and registration fees. The high value ($0.49 per mile) reflects both ownership and the costs associated with vehicle use, including fuel, repairs, and depreciation.

2.2 Results

Table A-3 displays the calculated vehicle cost savings for 2030 expressed on an annual (2004$) basis. The cost savings are based on a total reduction of 257 million vehicle miles traveled between the two alternatives that were evaluated.

The variable operating cost savings are costs that can be more readily anticipated as savings

Table A-3 Annual Vehicle Cost Savings 2030 (2004$)

	Sound Move **Ten-Year System Plan**	***ST Vision*** **Long-Range System Plan**	***2030*** **Annual Vehicle Cost Savings**
VMT	31,537,090,000	31,280,013,000	257,077,000
Total Annual Vehicle Cost High ($)	$ 15,453,174,000	$ 15,327,206,000	$ 125,968,000
Total Annual Vehicle Cost Low ($)	$ 9,461,127,000	$ 9,384,004,000	$ 77,123,000

based on a reduction in automobile use. The reduction in ownership costs is more difficult to anticipate and estimate. Although individuals may depend on public transit for a greater share of their trips it is unclear how this will directly influence overall auto ownership patterns. The Congestion Relief Analysis assumed that 10 percent of the VMT shift could be explained by changes in vehicle ownership patterns and that the remaining 90 percent of the VMT reduction is due to changes in vehicle use. The CRA report acknowledged, however, that the assumption was somewhat conservative and that an alternative that includes a significant transit investment could be expected to influence auto ownership patterns to a greater extent.

The *Economic Analysis of Sound Move* estimated vehicle cost savings to be approximately $80 million in 2010 (1995$). This estimate compares to the lower end of the range calculated in the PSRC analysis. While these savings are significant, there is much uncertainty regarding their calculation. Uncertainty in estimating vehicle costs stems from possible advances in motor vehicle technology, public policies regarding vehicle flows and congestion, and local vehicle depreciation trends. Additionally, vehicle cost models do not necessarily cover all aspects of road conditions, features of vehicles, and driver characteristics that may affect costs. Finally the most crucial variables in the analysis are data on vehicle types, utilization, and road conditions. This data is too expensive and time-consuming to be collected in any form other than the aggregate. Given the uncertainty associated with these estimates, the values were conservatively calculated.

Truck costs are not addressed separately in this analysis primarily because these estimates require data that varies dramatically according to location, market conditions, and other factors. Truck costs can generally be much higher than other vehicle cost. For example, truck costs have been estimated at $1.038 per mile based on an analysis by the Owner-Operator Independent Driver's Association (OOIDA).[41] Additionally, parking cost savings are not included in these estimates and, according to some researchers, could have a substantial impact on economic savings.

Transit Option Value

3.1 Sources and Methods

The reports that were reviewed suggest a variety of methods and examples to determine the value of having transit as an alternative travel option. A common method used is to determine the average cost of an auto trip in the region and multiply that by the number of trips that an auto user might take without their vehicle during the course of a given year. Then a value is applied that reflects the volatility or reliability of a car trip due to congestion levels, bad weather, maintenance needs, gas prices, or other factors. This method can produce results that are significantly different, depending on local conditions and assumptions on the reliability/volatility of a car trip. Other qualitative methods are suggested in the literature that identify issues related to a specific project and assign an expected decrease or increase based on the potential response of new transit users or a driver's willingness to pay for the availability an alternative option.

The Regional Council analysis uses an approach modified from the TCRP Report 78 based on vehicle trip operating costs, travel time values, and a volatility factor that represents the potential unreliability of an auto trip. This approach is adapted from methods that are described in national resources and relies on a number of assumptions regarding whether an individual is likely to choose transit instead of an automobile. The option value of transit depends on the availability of transit service at a cost that is reasonably close to the cost of an auto trip for the affected portion

[41] Owner-Operator Independent Driver's Association (OOIDA), based on fixed costs (vehicle payments, insurance, and licensing) and variable costs (fuel consumption, maintenance, charges, tolls, scale fees, worker's compensation, taxes, and other miscellaneous expenses).

of the population. The key factors used to estimate the transit option value in this analysis include:

- **The average cost of a transit trip.** This factor is the marginal full cost of taking the trip by transit, including out-of-pocket costs, travel time, and other travel characteristics. Since transit is not the typically used mode, its expected price must generally be higher than an auto trip. An estimate for the average cost of a transit trip was calculated to be $12.72 for the *ST Vision* and $13.36 for *Sound Move* based on the average transit fare ($1.50) and average transit travel time costs ($11.22 and $11.86 respectively). For the purposes of the option value calculation, transit travel time value is fixed at 50 percent of the prevailing wage rate and average transit trip times were estimated from the travel demand model – 59 minutes for the *ST Vision* and 62 minutes for *Sound Move*.

- **The average cost of an automobile trip.** Since transit is most viable for commute trips, this factor was estimated based on the full marginal cost (auto operating costs plus the dollar value of time spent traveling) of a typical commute trip. The estimate for the average cost of an auto trip is $9.57 for the *ST Vision* and $9.73 for *Sound Move*. This is consistent with previous calculations for vehicle costs ($0.49 per mile), average trip distances from the travel model (9.019 miles for the *ST Vision* and 9.083 miles for *Sound* Move), calculations for auto travel time value, and average trip times from the model (24.04 minutes for the *ST Vision* and 24.723 minutes for *Sound Move*).

- **The volatility of automobile trip costs.** This factor captures the volatility or uncertainty of travel by auto. WSDOT freeway vehicle speed data was used to measure the volatility in speed during the a.m. peak (7:30) and p.m. peak (4:30) for the primary commutes during 2002. This data represents the average auto trip cost increases due to unreliable road conditions as a result of high volumes, bad weather, traffic incidents, or other causes. On average, travel speeds deviated 24 percent from the mean in the p.m. and 28 percent in the a.m. Based on this data, using the mean between the speed volatility in the a.m. and p.m. (26 percent), the volatility of auto trip costs due to congestion was determined to be $1.29 above the average auto trip cost of $9.57 for the *ST Vision* and $1.33 above $9.73 for *Sound Move*.

- **The expected number of trips per year that an auto user might use transit.** This factor captures the frequency of transit use by a person who typically uses an automobile for travel. Puget Sound Transportation Panel (PSTP) survey attitude data was used to estimate the number of times a typical non-transit user might actually use transit during a typical year.[42] During the years covered by the Panel Survey, the number of optional transit trips taken by this population ranged from 2.5 to 3.4 trips per year.

3.2 Results

Given forecasts of approximately 2.5 million one-way a.m. person trips in 2030, we estimate a total region-wide annual option value of $13.5 million to $14.4 million under the *Sound Move* alternative and $13.8 million to $14.9 million under the *ST Vision* alternative. The difference between these figures represents the additional option value resulting from the incremental increase in high capacity transit investments. The annual option value is calculated to be within the range of $279,000 to $500,000 in 2030 expressed in 2004 dollars.

[42] Puget Sound Transportation Panel (PSTP) Attitude Survey, Data for selected years between 1990 - 2000

The calculations conducted as part of this analysis rely on assumptions regarding whether an individual is likely to choose transit instead of an automobile for a limited number of trips each year. The average cost of an auto trip and a transit trip are relatively easy to estimate with some accuracy. On the other hand, the volatility of auto trip costs and estimating the number of times an auto user might need to use transit are much more difficult and can vary widely. Due to these uncertainties, conservative assumptions were used and the resulting annual option value calculations could significantly understate actual benefits.

The number of optional transit trips assumed in this analysis (2.5 to 3.4 per year) was extrapolated from Panel Survey data that is based on a one-week period during a given set of years during the 1990s. The influence of the improved transit services that would exist in the future and the additional anticipated constraints to the roadway system are not factored into this estimate. One might expect more discretionary transit trips taken by the auto user after the high capacity transit system is complete due to more severe congestion levels in the future and the potentially higher level of accessibility associated with the transit improvements. In addition, the surveys may not fully capture the random nature of occurrences that necessitate an auto user to shift to transit for certain trips each year.

The assumptions used to estimate the volatility of auto trip costs should also be considered as being conservative. For this analysis, the standard deviation or volatility of the expected price of an automobile trip was assumed to be $1.29 to $1.33, depending on the plan alternative. The method used to estimate this volatility, based on average region-wide travel speeds, could be expected to wash out much of the volatility that an actual user on a given facility could experience on a day-to-day basis. In addition, the method does not factor in other reasons why an auto user might need to depend on transit periodically. Factors such as high gas prices and the number of times a vehicle is in for repairs are not considered in this calculation because they are difficult to estimate and forecast into the future.

Air Quality Benefits

4.1 Sources and Methods

In general, two types of air quality analyses can be conducted to estimate the impacts of a proposed set of transportation projects. An area-wide analysis can be done that estimates the total amount of pollutant emissions that would be generated by different transportation projects or groups of projects. Actual emission levels can be computed based on the latest version of the EPA model, known as MOBILE. These models consider the mix of vehicle types (e.g., cars, trucks, transit vehicles), number of cold starts, average speeds, pavement types, and other factors that contribute to vehicle emissions along major roadways. In the absence of this detailed modeling, estimates can be made using national research on levels of pollutants generated based on regional vehicle miles traveled. A localized analysis can also be conducted to estimate pollutant concentrations based on more specific information, such as land use development characteristics and the level of roadway congestion at specific intersections.

For this analysis, an area-wide analysis was conducted for the region as a whole – defined as the Sound Transit service area. Detailed air quality modeling was not conducted as part of this analysis. Air quality impacts are calculated based on rough estimates of emission levels for various pollutant types per vehicle miles traveled. Costs are then assigned for particular types of pollutants based on dollar value per kilogram of output. Reductions in region-wide vehicle miles traveled were estimated based on the travel demand model alternatives, *Sound Move* and *ST Vision*. U.S. Environmental Protection Agency (EPA) data is used to estimate the potential

output of pollutants expressed in grams per mile as shown in *Table A-4*.[43] EPA data was used to estimate kilograms of emissions per vehicle miles traveled for hydrocarbons (HC), carbon monoxide (CO), and oxides of nitrogen (NOx), particulate matter (PM10) and sulfur oxides (SOx). The EPA figures used are estimates for private passenger cars and do not differentiate between vehicle types.

Table A-4 Emission Level Per Mile					
	PM10	VOC/HC	CO	NOx	SOx
Grams per mile	0.25	2.8	20.9	1.39	0.2

U.S. Environmental Protection Agency, 2000

Table A-5 Pollutant Costs Per Emission Level					
Cost per kilogram	PM10	VOCs	CO	NOx	SOx
Low	$14.59	$0.29	$0.01	$2.19	$11.67
High	$201.29	$2.19	$0.15	$27.71	$100.65

TCRP report p.II-37 (Table 4-3) – Delucchi 1998, Adjusted to 2004$

To estimate the cost per output of each pollutant, a range of costs were selected from the available literature and are shown in *Table A-5*. Low and high air pollution cost estimates were used to calculate a range of potential cost savings in 2004 dollars. These cost estimates are based on national research and include impacts to health, visibility, and agricultural crops. The research conducted reflects the wide range of national estimates per kilogram of output for identified pollutants.[44]

4.2 Results

This analysis quantifies air quality impacts primarily as a function of the change in vehicle miles traveled between the two plan alternatives. The travel demand model forecasts that in 2030 there will be 257 million fewer vehicle miles traveled under the *ST Vision* than the *Sound Move* alternative, primarily due to an increased share of public transit travel. The annual air quality savings is calculated to be within the range of $2.6 million to $30.4 million in 2030 expressed in 2004 dollars. For comparison purposes, the *Economic Analysis of Sound Move* estimated air quality savings to be approximately $6.9 million in 2010 (1995$).

The wide range in potential air quality benefits in this analysis is a result of the variation in cost information available for estimating the value of pollutants per kilogram of output. All of the cost factors per output used as assumptions reflect significant variations ranging from a 750 percent variation in VOC costs to a 1,400 percent difference in PM10 costs. These ranges represent the wide variation in how researchers have valued the impacts associated with these pollutants.

The large number of variables that affect air quality levels makes it difficult to estimate accurately the air quality impacts on a regional basis. For more accurate estimates of air quality impacts, additional information on fleet and trip characteristics, level of traffic congestion, the location of project facilities relative to sensitive land uses, and local meteorological conditions and pollutant levels would need to be collected. Recognizing the uncertainties inherent in making these estimates, it is not unexpected that this assessment includes highly variable cost savings.

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[43] *Average Annual Emissions and Fuel Consumption for Passenger Cars and Light Trucks*, U.S. Environmental Protection Agency, Office of Transportation and Air Quality, EPA420-F-00-013, September 9, 2004

[44] *Environmental Externalities of Motor Vehicle Use in the U.S*, UCD-ITS-RP-00 (14), Delucchi, Mark A., Institute of Transportation Studies, University of California 2000.

Appendix B: National Studies on Property Value Impacts

The following reports and studies offer varying levels of evidence that different forms of high capacity transit have a positive impact on the values of residential and commercial properties. Most of the reports are limited to a correlation between the proximity of development to transit access, evaluating variations between properties that are nearer or further from a particular station. The application of such studies is limited in that transit is usually placed in dense locations with good transit markets that already experience higher property values and rents. The more intricate studies attempt to evaluate actual growth or decline in property values over time or as values change in accordance with increases in transit ridership.

Impacts of Rail Transit on Property Values
Recent studies of the impact of twelve rail projects (including both heavy rail and light rail) throughout North America are compared. In general, proximity to rail is shown to have positive impacts on property values. The relative increase in accessibility provided by the new transit investment is the primary factor in increasing property values.[45]

Dallas, TX
Examining the 1997 to 2001 time period, the study revealed that proximity to a DART station exerts a positive influence on property valuations. Median values of residential properties increased 32.1 percent near the DART rail stations compared to 19.5 percent in the control group areas. For office buildings, the increase was 24.7 percent for the DART properties versus 11.5 percent for the non-DART properties.[46]

Chicago, IL
A study of the regional benefits or comparative advantages transit provides to neighborhoods by improving accessibility, lessening congestion and reducing transportation costs found that residential locations served by transit were more valuable than comparable locations without transit service. Whether located in lower- or higher-income neighborhoods, proximity to CTA and Metra stations positively affects the value of single family homes. Furthermore, apartment properties located closer to train stations tend to realize higher rents and occupancy levels than comparable apartments less conveniently-located to train stations.[47]

Boston, MA
Single-family residential properties in metropolitan Boston, Mass, are examined. Results indicate that there is an increase in single-family residential property values of approximately 6.7 percent by virtue of being located within a community having a commuter rail station. At the regional level there appears to be a significant impact on single-family residential property values resulting from the accessibility provided by commuter rail service.[48]

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[45] Impacts of Rail Transit on Property Values. Roderick B. Diaz, May 1999.
[46] An assessment of the DART LRT on taxable property valuations and transit oriented development. Bernard L. Weinstein & Terry L. Clower, September 2002.
[47] CTA and Metra stations on residential property values. A report to the Regional Transporation Authority. June 1997
[48] Impacts of commuter rail service as reflected in single-family residential property values. Robert J. Armstrong, Jr., 1994.

San Francisco, CA
The Sedway Group's review of studies on the benefits associated with BART service in the Bay Area identified positive residential and office property impacts. Single family homes were reported to be worth $3,200 to $3,700 less for each mile distant from a BART station in Alameda and Contra Costa counties. Apartments near BART stations were found typically to rent for 15 to 26 percent more than apartments more distant from BART stations. The average land price per square foot for office properties also decreased as distance from a BART station increased, from $74.00 per square foot within one-quarter mile of a station to $30.00 per square foot for more than a half-mile distant.[49]

Washington DC and Atlanta GA
Data results were examined for five rail stations in the Washington DC and Atlanta areas. Average office rents near stations rose with systemwide ridership; joint development projects added more than three dollars per gross square foot to annual office rents. Office vacancy rates were lower, average building densities higher, and shares of regional growth larger in station areas with joint development projects. Where regional market conditions are favorable, rail transit appears capable of positive impacts on station area office markets.[50]

Santa Clara County, California
This research uncovered significant capitalization benefits on commercial properties of proximity to rail transit. Being within walking distance of a LRT station in Santa Clara County CA, increased land values on average by over $4.00 per square foot, or by around 23 percent. And for properties in commercial business districts and within a quarter mile of a CalTrain commuter rail stop, the capitalization premium was even larger - over $25 per square foot, or more than 120 percent above the mean property value. [51]

San Diego, CA
The San Diego study found appreciable land-value premiums for different land uses in different rail-transit corridors in San Diego County. The most appreciable benefits were: 46% premiums for condominiums and 17% for single-family housing near Coaster commuter rail stations in the north county; 17% and 10% premiums, respectively, for multifamily housing near East Line and South Line Trolley stations; and for commercial properties, 91% premiums for parcels near downtown Coaster stations and 72% for parcels near Trolley stations in the Mission Valley.[52]

Los Angeles
In the Los Angeles study, while some instances of land-value premiums were found, overall impacts were uneven and inconsistent. In the case of the Red Line, multifamily housing near subway stations accrued benefits; for other uses, nearby properties tended to sell for less. Stronger premiums were found for the Metrolink commuter rail system, with the exception of the Orange and Ventura corridors. Light-rail transit services conferred the largest benefits to multifamily housing and commercial uses. One possible explanation for the lack of clear and consistent premiums in Los Angeles may be that many rail station areas are in distressed settings and redevelopment districts.[53]

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[49] Regional impact study commissioned by Bay Area Rapid Transit District (BART) July 1999.
[50] Rail transit and joint development: Land market impacts in Washington, DC and Atlanta. Robert Cervero, 1994
[51] Robert Cervero & Michael Duncan, November 2001.
[52] Land value impacts of rail transit services in San Diego County. Robert Cervero & Michael Duncan, June 2002.
[53] National Association of Realtors and the Urban Land Institute sponsored research by the University of California, Berkeley.

Appendix C: Case Studies of Economic Analysis in Other Regions

This section describes the economic benefit analyses undertaken in five U.S. regions, including Dallas (TX), Phoenix (AZ), Chicago (IL), San Diego (CA), and Portland (OR). These regions were selected based on the applicability of the studies conducted to the central Puget Sound region. The case studies reflect a wide range of analysis methods prepared for high capacity transit systems in varying stages of development. Each case study identifies the relevant organizations in each region, individual reports that were prepared, and some of the key findings.

Case Study: Dallas, TX

Organizations: North Central Texas Council of Governments (NCTCOG), Dallas Area Rapid Transit (DART), City of Dallas.

Reports:

1) *The Initial Economic Impacts of the DART LRT System*, Weinstein, Bernard L. & Clower, Terry L., University of North Texas Center for Economic Development & Research, prepared for Dallas Area Rapid Transit, July 1999. http://www.unt.edu/cedr/dart.pdf
2) *DART Light Rail's Effect on Taxable Property Valuations and Transit-Oriented Development,* Weinstein, Bernard L. & Clower, Terry L., University of North Texas Center for Economic Development & Research, prepared for Dallas Area Rapid Transit, January 2003.
3) *NW Corridor: LRT Line to Farmers Branch and Carollton FEIS*, UDOT, FTA, DART, October 2003.
4) *SE Corridor FEIS*, UDOT, FTA, DART, October 2003.

Stage of Planning: Completed regional transit system, alternative alignments identified for future extensions.

Overview:

The North Central Texas Council of Governments (NCTCOG) is the metropolitan planning organization (MPO) for the 16 county region surrounding Dallas and a number of smaller cities. Dallas Area Rapid Transit (DART) is the regional transit authority for the Dallas region. The Diversity and Economic Opportunity Department at DART entered into a memorandum of understanding with the Dallas Chamber of Commerce in order to support economic development within the DART service area (http://www.dart.org/images/deo/MOUDBCC.pdf). This work includes a standing committee and a joint annual report with monthly status reports on shared economic development goals. Four reports were reviewed that directly relate to economic benefits of high capacity transit. Report #1 focuses on a "before and after study" to identify and measure economic impacts specific to the light rail system, and report #2 evaluates changes in property values and the potential for transit-oriented development. Reports #3 and 4 contain specific impacts related to specific light rail alignments and include a review of academic and professional literature on rail transit and real estate impacts.

Economic Benefits Evaluated:

- Taxable property values 1994-1998 and more recent years (using a separate methodology 1997-2001).
- Occupancy and rental rates for office, retail, and industrial property.

- Retail sales mid-1997 to mid-1998.

Methodology:
- Properties located near DART stations were evaluated in the context of commercial, industrial, and residential property in comparable neighborhoods not served by DART (report #1,2).
- Surveys of business leaders, planners, and elected officials to determine the level of support and implementation for public transportation to aid business sales and other economic benefits (report #1,2).

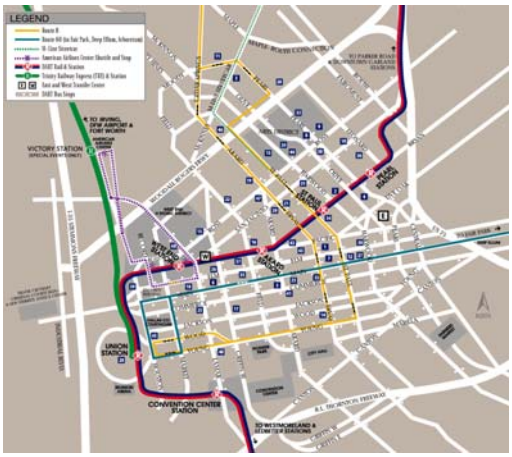
Findings:
- Literature reviewed indicates that it is difficult to determine whether rail systems in other regions have had a direct, positive impact on real estate without joint development agreements and other incentives. It was found that transit systems rarely generate new regional growth, however, with supportive public policies and favorable real estate market conditions, transit systems can be used as a planning tool to redistribute growth.
- Property values near DART stations were found to be valued 25 percent greater than properties in the control neighborhoods (1994-1998). Later studies (1997-2001) indicated that the median values have continued to rise at a faster rate (32.1 percent near stations and 19.5 percent in the control group areas). It was found that there was a 39 percent greater value increase near stations for all properties, a 53 percent greater increase for office buildings, and little impact on industrial property.
- Proximity to DART stations was a particular boost to occupancy and rental rates in Class A and Class C office buildings and strip retail.
- Retail sales in the Dallas CBD (areas served by LRT) increased by 36.2 percent, as compared to 3.6 percent citywide (areas with and without LRT).
- Survey respondents were found to support public transportation to: 1) spur development and redevelopment in surrounding communities, 2) provide an alternative to the automobile, and 3) improve air quality to avoid possible sanctions by the EPA.

Summary:
The analyses conducted in Dallas highlights the need to analyze joint agreements, incentives, and other zoning changes concurrently with station proximity to evaluate real estate development potential. This case study also indicates a stronger correlation between high capacity transit development and office/retail than between high capacity transit and residential development. The development of transit corridors that target centers was determined to be an effective strategy for economic development. The Dallas case study identified the need to survey existing business leaders and others in order to evaluate how well received a new system is likely to be in specific areas in the region. Appendix B includes additional information on property benefits that have occurred in the Dallas region.

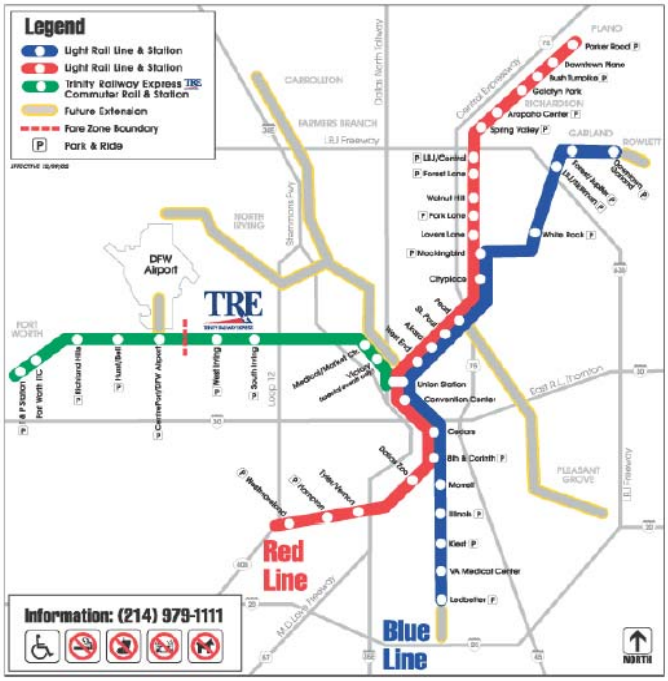
Figure C-1.

Existing & Planned Transit Systems In Dallas:

- Two light rail lines, streetcar, & one commuter rail line.
- Three major extensions under development.



http://www.dart.org/maps/downtowndallasmap.htm



http://www.dart.org/maps.asp?zeon=RailMap

Case Study: Phoenix, AZ

Organizations: Valley Metro, Maricopa Association of Governments, City of Phoenix, City of Tempe, City of Mesa, Maricopa County.

Reports:

1) *Light Rail Transit Phoenix, Arizona: Economic Development Along The Planned Light Rail Line,* The Urban Land Institute Advisory Panel Report, prepared for Valley Metro, December 2001.

Stage of Planning: One route in operation

Overview:

The Maricopa Association of Governments is the MPO for the Maricopa County region surrounding Phoenix. Valley Metro is the regional transit authority. The economic development departments of the light rail project's participating cities are actively pursuing development opportunities along the future light rail route to maximize the public's investment in light rail infrastructure. Valley Metro conducts business assistance seminars along the proposed alignment that provide training and resources for business and marketing plans, special loan programs, strategies to sustain sales and cash flow, and tips on efficient operation. The Urban Land Institute Arizona was asked to study potential land uses around four light rail stations along the transit line with particular attention given to market potential of development.

Economic Benefits Evaluated:

- Retail sales.
- Occupancy and rental rates for office, retail, and industrial property.
- Taxable property values.
- Market demand by building product type.

Methodology:

- A return on investment study was conducted by the Center for Economic Development and Research at the University of North Texas (as part of report #1).
- ULI Arizona conducted a study on market potential related to land uses surrounding the proposed and existing stations (report #1).

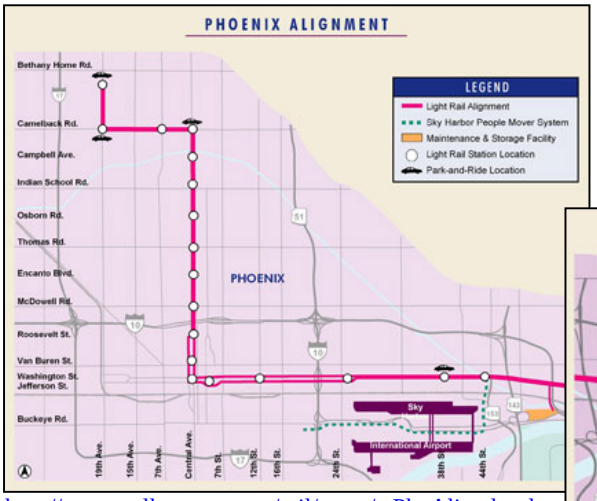
Findings:

- Property values around light rail stations had a 50 percent greater increase in value than comparable properties in nearby areas without light rail. In general, occupancy rates and rents increased along the rail route, particularly Class A office and industrial space. Vacant land values appreciated five times faster around stations.
- According to the Valley Metro, "…light rail has helped promote infill development in city core areas. However, it is important to note that light rail itself does not cause economic development to happen. Successful economic development is usually a result of municipalities, developers and real estate professionals working in partnership to optimize the development opportunities created by the number of people using light rail systems."

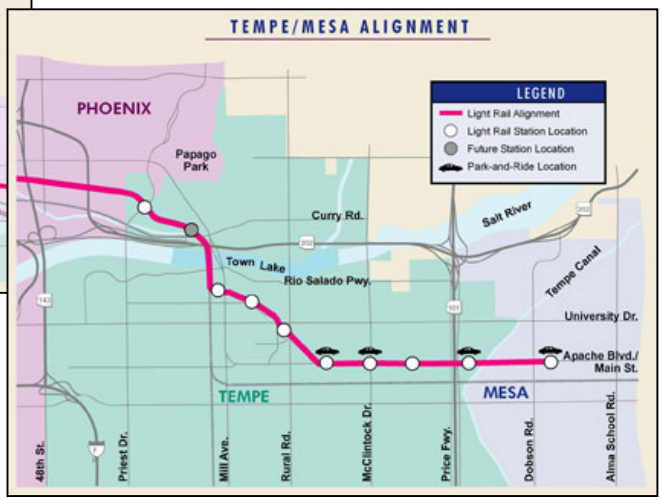
Summary:

The findings will be compared with findings from other regions and incorporated into the Regional Council report discussion on the potential sales and property value impacts that would occur in the Central Puget Sound if similar trends were realized.

Figure C-2



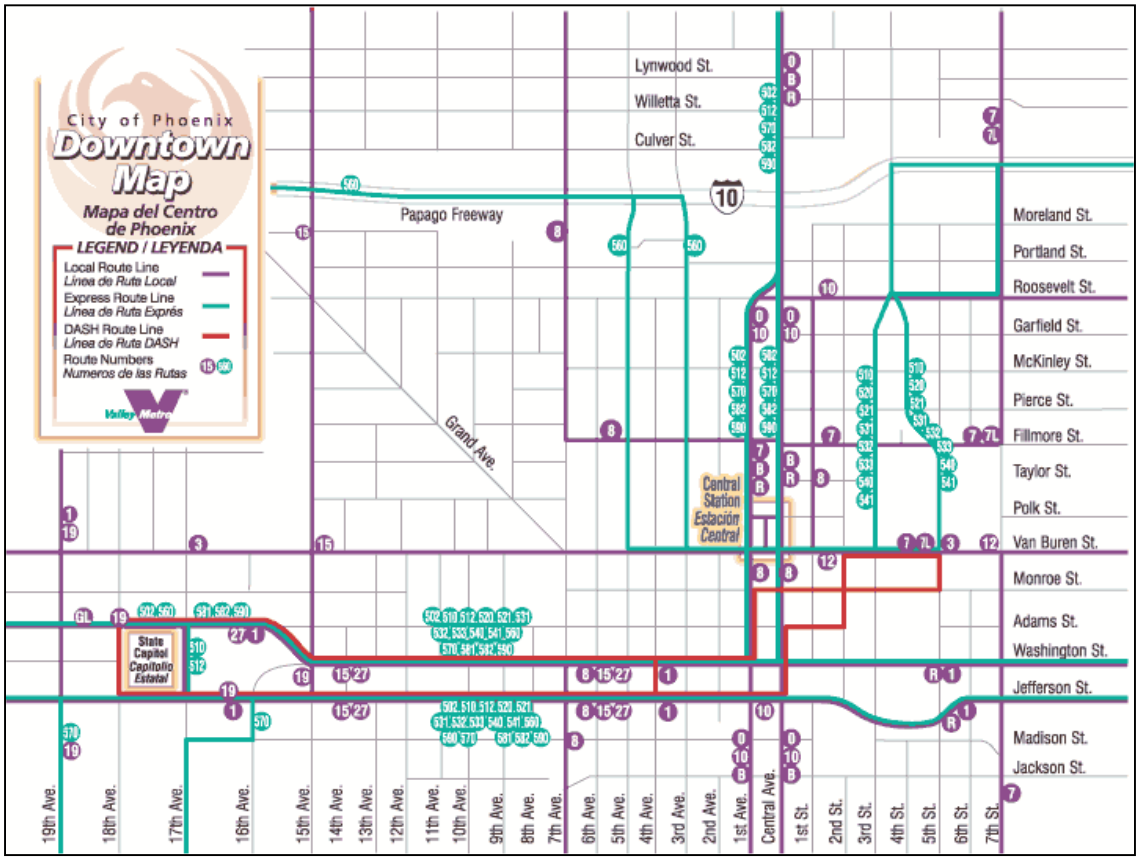
http://www.valleymetro.org/rail/maps/wPhxAlign.html#P-5_0



http://www.valleymetro.org/rail/maps/wTempeMesaAlign.html#P-5_0

Existing & Planned Transit Systems In Phoenix:

- Extensive regional bus system.
- Proposed light rail line.



http://www.valleymetro.org/transit/System/Downtown.htm

Case Study: Chicago, IL

Organizations: Chicago Area Transportation Study (CATS), Chicago RTA (Cook, DuPage, Kane, Lake, McHenry and Will counties), Chicago METRA, Chicago Transit Authority (CTA), PACE, City of Chicago.

Report(s):

1) *Local Economic Impacts in Commuter Rail Station Areas: Recommendations for Reinforcing the Commuter/Merchant Interface,* Camiros, Ltd., Valerie S. Kretchmer Associates, Inc., and Metra, Chicago, Illinois, December 1994.
2) *The Market for Transit-Oriented Development: Proceedings of a Workshop Presented by the Regional Transit Authority of Northeast Illinois,* Regional Transit Authority of Northeast Illinois, Chicago, Illinois, November 13, 1995.
3) *Diverting Auto Users to Transit: Early Lessons from CTA's Orange Line,* Market Research Department, Chicago Transit Authority, January 1997.

Stage of Planning: Multiple routes in operation

Overview:

CATS is the MPO for the Chicago area. The Chicago regional transit authority (RTA) is a special purpose unit of local government and a municipal corporation of the state of Illinois serving 6 counties. The RTA has three service boards (the CTA, Metra commuter rail and Pace suburban bus) to handle all the transit system's operating and fare responsibilities. The RTA has invested in efforts to divert auto users to transit by developing a widely accessible rail and bus system and strategically marketing the benefits in communities within specific transit corridors. There are a number of reports directly related to economic benefits of transit within the region. Two of the reports focus on commuter rail stations and one report evaluates the market potential for transit-oriented development.

Economic Benefits Evaluated:

- Sales at station-area stores
- Local sales tax benefit from non-resident commuter rail users
- Diversion of auto users to transit
- Travel time
- Air quality impacts, including VMT and cold starts for vehicles

Methodology:

- A survey of 1,635 commuter rail users during peak hours, 195 station area merchants, and a small number of realtors (report #1).
- Data on sales attributable to commuters in station areas that have a representative mix of businesses (report #1).
- Additional on-board rider survey compared to 1990 Census demographic and travel data in market area surrounding commuter rail corridor (report #3).
    - Non-workers in auto-owning households are assumed to be potential auto users.
    - Travel time evaluated by mode along 11.3 mile corridor.
    - Calculated number of cold starts and VMT with likely drivers and with drivers now using transit system.

Findings:

- Merchant surveys indicate that 5-10 percent of their sales are from commuter rail users.
- An average commuter rail user spends $20-30 per week at station-area stores.

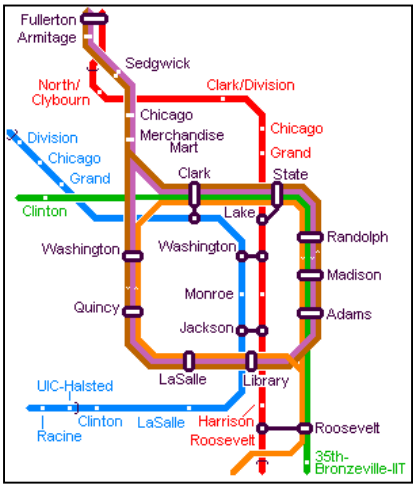
- "If a suburban station had 1,500 passengers per day… these passengers would generate over $1,500,000 in sales per year… This could mean as much as $15,000 to$20,000 in increased sales tax revenue for the community, and result in the creation of eight to fifteen new jobs in the community." – John L. Lewis, Northern Illinois University.
- 65 percent of respondents considered location near a station an important factor in their decision to live in a particular area.
- 16 out of 17 residential brokers indicated convenient access to commuter rail service was either 'essential' or 'very important' in marketing homes and condominiums.
- 11 out of 17 brokers felt that "all other factors being equal, having commuter rail service nearby increases residential property values".
- Of the 1993 assessed valuation at $438 million for the areas around the commuter rail, $28 million was attributable to the rail system resulting in $66 million in total additional tax dollars.
- There is a higher value in single-family residential property values of approximately 6.7 percent by virtue of being located within a community having a commuter rail station.
- Shopper goods and professional services accounted for 24 percent of the total land use in station areas in this study.
- More than one quarter of daily transit boardings represent former automobile commuters or new trips for which auto was a candidate.
- Auto conversion went from 21-28 percent in 1994 and 3.2-5.1% transit share of total trips.
- 33-39 percent faster travel time than equivalent bus service in a.m. peak, roughly equal to travel times in automobiles.
- On the average weekday the system along this corridor avoids 5,700 cold starts and 100,300 VMT.

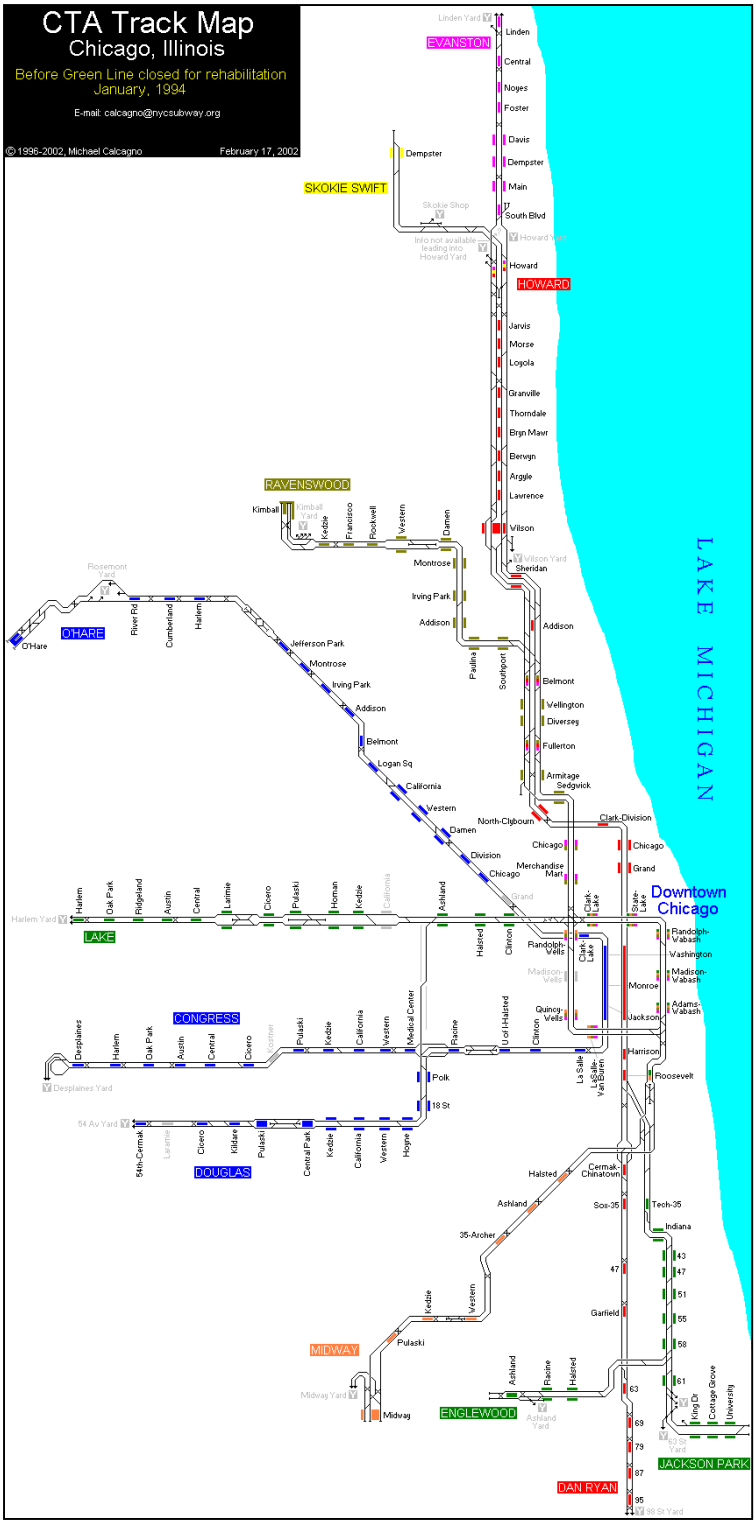
Summary:
Chicago has relied primarily on surveys from existing riders in order to evaluate the benefits associated with its rail system. The surveys were useful in determining perceived benefits identified by transit users and business in the market area. The study of transit-oriented development suggests that it is important to more firmly establish supportive zoning and policy surrounding high capacity transit stations in order to fully capitalize on transit-oriented development market potential. The design and placement of specific station-area businesses was determined to be essential to the success of the area and, in the long-term, the transit service itself.

Figure C-3.

Existing & Planned Transit Systems In Chicago:

- Extensive Commuter Rail network, 7 El-train lines, & free Trolley system.
- Additional 55-mile DMU line under development.





http://www.transitchicago.com/maps/systemmaps.html http://www.lightrail.com/maps/maps.htm

Case Study: San Diego, CA

Organizations: San Diego Association of Governments (SANDAG), San Diego County, City of San Diego, Metropolitan Transit Development Board (MTDB).

Selected Report(s):

1) *Economic Contributions of Public Transit in the San Diego Region,* San Diego Association of Governments, June, 1996.
2) *San Diego Trolley: The First Three Years,* San Diego Association of Governments, prepared for Urban Mass Transportation Administration, U.S. DOT, Washington, D.C., 1996.
3) *Land Value Impacts of Rail Transit Services in San Diego County,* Cervero, Robert & Duncan, Michael, prepared for National Association of Realtors and Urban Land Institute, June 2002.
4) *Land Use Effects of Light Rail Transit: The San Diego Example,* W. Graham, Department of City Planning, San Diego State University, unpublished Master's Thesis, 1992.
5) *Analysis of the Impact of Light Rail Transit on Real Estate Values,* VNI Rainbow Appraisal Service, Metropolitan Transit Development Board, San Diego, 1992.
6) *Capitalization of Transit Investments into Single-Family Home Prices: A Comparative Analysis of Five California Rail Transit Systems,* J. Landis, Institute of Urban and Regional Development, University of California, Working Paper 619, Berkeley, CA, 1994.
7) *Transit-Induced Accessibility and Agglomeration Benefits: A Land Market Evaluation,* Institute of Urban and Regional Development, University of California, Working Paper 691, Berkeley, CA, 1997.

Stage of Planning: Completed regional transit system with proposed extensions.

Overview:

The San Diego Metropolitan Transit Development Board (MTDB) is the regional transit authority. San Diego Association of Governments (SANDAG) is the Metropolitan Planning Organization for the region. SANDAG has attempted to assess the local economic benefits of public transit in order to justify future expenditures and promote use and development along transit corridors. The governmental association uses its Demographic and Economic Mapping System (DEMS) and Regional Economic Development Information (REDI) to perform economic impact analysis for local governments. The report prepared for the National Association of Realtors presents detailed research on the land value impacts of rail services in San Diego County.

Economic Benefits Evaluated:

- Monetary savings due to congestion relief, including reduced vehicle operating costs and the value of time savings for off- and on-the-clock time.
- Economic stimulus from federal/state funds such as direct job creation and business sales.
- Air quality improvements, including cost savings related to reduced emissions and the associated health benefits.
- Better job access for lower-income persons, higher levels of employment and average income, and improved business productivity and sales
- Reduced energy consumption.
- Expanded tourism measured by visitor spending and the number of conventions.
- Reduced traffic injuries and fatalities resulting in human and economic loss

- Increased mobility measured by the time/money savings due to less chauffering and educational access for non-drivers.
- The potential for TOD development, including summarized survey responses from merchants and developers.
- Land value impacts in non-station areas vs. station areas including rental data, single-family home prices, and land value premiums and discounts.

Methodology:

- Report #1 attempts to estimate the minimum annual benefits and compares this with the local annual taxes used. This only accounts for the quantifiable economic benefits. Other benefits are discussed.
- Report #2 includes surveys of developers and merchants along an existing line after only a few years of operation to evaluate whether the system contributed to surrounding businesses.
- Report #3 used hedonic price theory with parcel records on multi-family housing, condominiums, single-family housing, and commercial property in order to assess land value changes associated with rail lines. The Metroscan real estate data source provided additional information on the evaluated properties.
- Report #4 qualitative case assessments on TOD development associated with light rail stations were conducted.
- Report #5 looked at rent differences between station and non-station areas, forming matched pairs among properties that are comparable except that some were located near rail stops and others were not.
- Reports #6 & 7 used home sales data to compare areas near and far from rail stations to determine whether the HCT system has had an impact.

Findings:

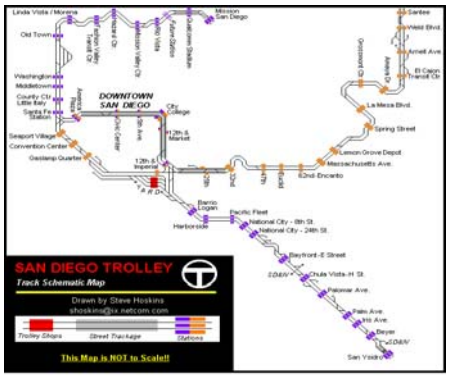
- For the $143.3 million dollars in local taxes spent on an annual basis, the transit system returns $296.5 million to the economy.
- Surveys revealed that 20 percent of merchants indicated that the Trolley was an important positive factor in the business remaining in its current location. Also, 40 percent indicated that the system had no impact on their sales volume. The effects of the rail system may have been under reported because merchants and developers were surveyed at an early stage of operation.
- Positive capitalization impacts were found for multi-family parcels along all Trolley and Coaster corridors, generally in the range of 2 to 6 percent. Around 91 percent premiums were found for parcels near downtown rail stations, but commercial properties accrued small or even negative capitalization benefits in other rail-served corridors.
- The case assessments concluded that relatively little suburban development could be associated with the presence of light-rail stations, though pro-active government involvement led to clustering of commercial and office development near some downtown stops.
- Looking at contract rents without being adjusted for occupancy indicated that no measurable differences in monthly rents were found for offices adjacent to downtown trolley stops versus offices of similar quality in the suburbs. In the case of retail businesses, fairly significant benefits were recorded, around $1.35 per square foot (in 1980 currency). Monthly rents for retail establishments adjacent to Trolley stations were, on average, 167 percent higher than control properties that were one-half block away. The study indicates that accessibility benefits were converted to better retail rents.
- For every meter closer a single-family home is to a Trolley station, its 1990 home price is $2.72 higher in value. While the accessibility premium associated with the San Diego Trolley is quite high, it is limited in extent to homes in the City of San Diego.

Summary:
SANDAG was particularly selective in what it chose to quantify for its economic analyses. Report findings from San Diego may be applied to the "return on investment" discussion as an indication of how beneficial transit systems can be using local resources. It will be important to indicate that federal resources are often used to supplement local resources and provide funds that may not be returned in order to provide less quantifiable benefits associated with transit systems. According to the report for the National Association of Realtors land-value premiums offer an objective, transparent, and tractable means of placing a monetary value on the benefits of being near transit stations. This report does not quantify land-value premiums, but the property value and land development changes are addressed qualitatively. According to the report using hedonic price models to assess land value, gauging benefits using rental data can be problematic in that contract rents do not always capture the full array of concessions received by tenants. Studies must also look at occupancy when using rental data because benefits to non-homeowner properties are also important in evaluating the benefits of a high capacity transit system.

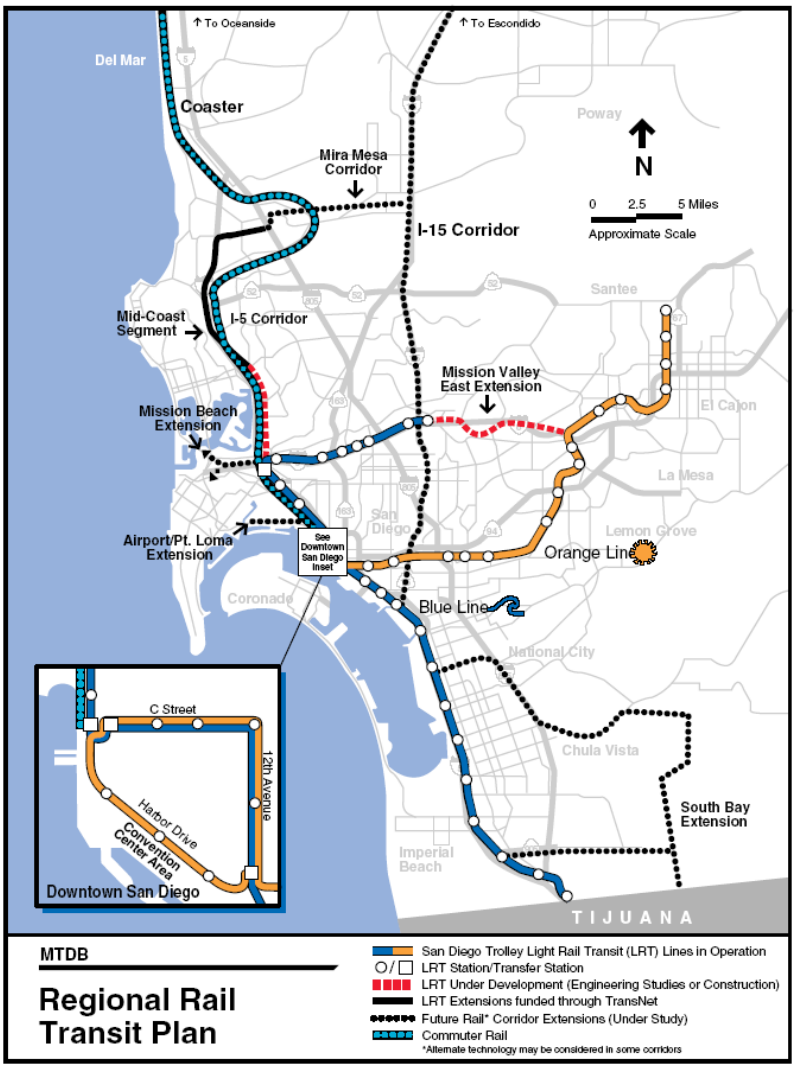
Figure C-4.

Existing & Planned Transit Systems in San Diego:

- Two light rail lines and one commuter rail line in operation.
- Two segments under development.



http://www.lightrail.com/maps/sandiego/sandiegomap.htm



http://www.sdcommute.com/agencies/MTS/MTDB/PDFs/regionaltransitfact.pdf

Case Study: Portland, OR

Organizations: Portland Metro Council, Tri-County Metropolitan Transportation District of Oregon (Tri-Met – Multnomah, Washington, and Clackamas counties), City of Portland.

Report(s):

1) *Transit Oriented Development: Trip Generation & Mode Split in the Portland Metropolitan Region,* Lapham, Michael, Portland State University, Portland, OR, 2001.
2) *Beyond the Field of Dreams: Light Rail and Growth Management in Portland,* G.B. Arrington, Jr., Tri-Met, September 1996.
3) *At Work in the Field of Dreams: Light Rail & Smart Growth In Portland,* G.B. Arrington, Jr., Tri-Met, September 1996.

Stage of Planning: Completed regional transit system with proposed extensions.

Overview:

METRO is the MPO for the region and Tri-Met is the RTA for the 3 counties surrounding Portland. The focus of the analysis in the Portland area has been on land development impacts. Tri-Met has claimed that light rail has generated over $1.3-1.9 billion in development adjacent to stations. Related studies in the area have been criticized for over reporting the benefits of light rail. Nevertheless, Portland has seen significant development in its downtown and other station areas, some either directly or indirectly related to the development of the light rail network.

Economic Benefits Evaluated:

- Mode split and trips per dwelling unit at transit station areas vs. similar non-station areas.
- Development dollars invested within a half-mile of the existing system.

Methodology:

- Counts for different modes were developed through visual observation at 8 transit stations to determine whether it reduced vehicle trips and increased pedestrian travel and transit use (7-9 AM Peak, 4-6 PM Peak). Trip counts were compared to ITE data for automobile trips generated by other types of development. Report #1 is an attempt to establish a connection between different transit oriented development attributes and varying levels of success (report #1).
- Comparison of assessed value of station-area properties and the countrywide average (report #2,3).

Findings:

- The average total daily transit ridership in the Portland region is roughly five percent. The average for the eight transit oriented developments studied is 16 percent during the a.m. peak period, and 11 percent during the p.m. peak period.
- The average trip generation rates for the station areas were well below the ITE rates for similar land use types. (a.m. peak hour rate at transit oriented developments is 0.41-0.51, for other apartments it is 0.62 – 0.63).
- Countrywide assessed values increased by 67.5 percent from 1980-1991, while station area values increased more dramatically at Lloyd Center (+134 percent); 162nd (+112 percent); and 181st (+491percent).
- 66 percent of station-area business owners said that their business had been helped by the MAX, 54 percent said they saw an increase in sales volume mostly related to business visibility.

- Over 1,450 multiple family units in 26 projects have been built next to suburban MAX stations at a value of nearly $50 million (report #2,3).

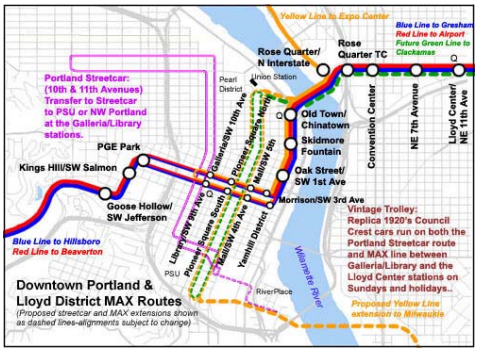
Summary:

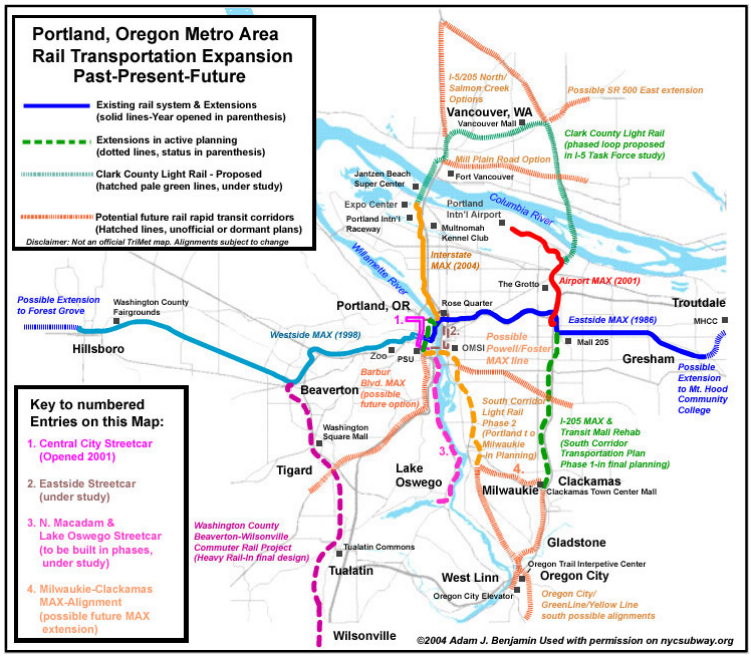
Most of the information out of Portland does suggest that there is a positive correlation between light rail and economic development. These studies on transit-oriented development suggest that it is important to more firmly establish supportive zoning and transit-oriented development policy surrounding high capacity transit stations in order to fully capitalize on transit-oriented development market potential. It was determined that few of the potential economic benefits would have been realized without joint development agreements and other efforts to promote development around stations. These issues will be incorporated into the in-direct benefits discussion in the Regional Council report.

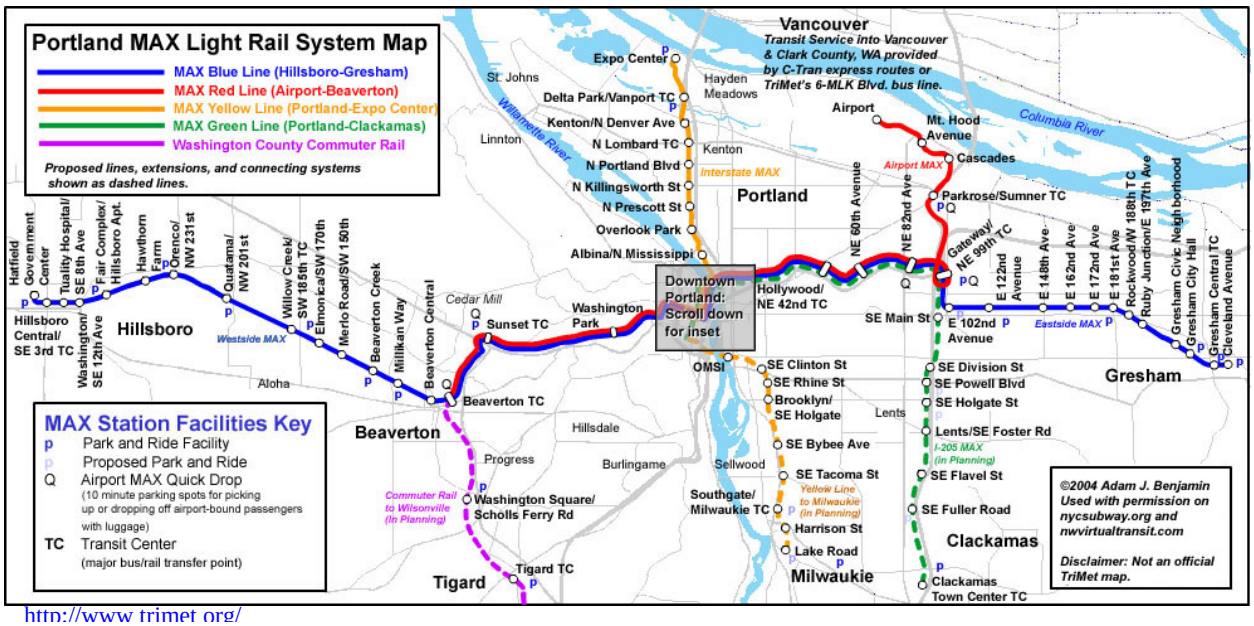
Figure C-5.

Existing & Planned Transit Systems In Portland:

- 4 light rail lines.
- One commuter rail line.
- One streetcar.
- One extension under development, other extensions under consideration.







http://www.trimet.org/

Appendix D: Summary of Selected Publications

A wide variety of research and analysis has been produced that focuses on estimating the economic impact of transportation investments. Below is a summary of selected national resources that provide a good assessment of best practices and state-of-the art methodologies. In combination with the case studies, these sources provide Regional Council staff with an excellent foundation for evaluating the direct and indirect economic benefits of developing a regional transit system. A full bibliography of sources is included in *Appendix E*.

National Cooperative Highway Research Program (NCHRP)

NCHRP Report 456: Guidebook for Assessing the Social and Economic Effects of Transportation Projects, Transportation Research Board, National Research Council, 2001.

The NCHRP report summarizes research that has been conducted on assigning value to travel time. The report indicates that the most commonly used estimate for the value of travel time is the prevailing wage rate in the area. The FHWA's Highway Economic Requirement System (HERS) is described in detail. This approach involves an evaluation of travel time in terms of budgets that people can withdraw from for different activities. Different values are assigned for in and out-of-vehicle travel times. Surveys are suggested as one method that can be applied to indicate the value of time based on a respondent's preferences for certain situations. Methods of evaluating reliability or travel time savings due to fewer incidents are also described.

Vehicle operating costs are discussed based on an assigned value of vehicle speed and roadway grades and conditions. The HERS approach is applied using a benefit-cost computer model able to estimate benefits of transportation improvements by comparing base and future conditions. Case studies are used to determine the option value of transit, comparing before-and-after situations for similar facilities, geographies, or projects. Other qualitative methods are suggested that identify important issues related to the project and assign an expected decrease or increase based on the potential of new transit users or drivers being willing to pay for the availability of better services. Other qualitative-based surveys and models are also highlighted.

Environmental savings are discussed, but the report indicates that much of the described methods can only be applied at the project level. The report provides a standard that involves look-up tables that depend on software applications with pre-calculated values for different highway scenarios and traffic noise prediction models that assign values based on the character of the transportation improvement. The report also describes how land use change can impact property values. Methods for the assessment of property values include market studies (a rough order of magnitude look at retail and service businesses that require access to a surrounding residential or business-oriented customer base), direct property comparisons (identifying a comparable transportation facility and corridor with similar land use and socio-economic characteristics in the local area and collecting information on rents and property prices for locations at varying distances from the facility before and after its development), and regression models that attempt to isolate the effects of transportation projects from other factors such as location and setting.

Job access and job creation can be measured using employer interviews highlighting the perception of transportation needs, constraints or threats to economic growth, and how the proposed project might impact local businesses and influence job growth. Market studies are described that include multiple surveys and models that measure the impacts of pass-by traffic, the average sales per visitor, and the observed market share according to changes in travel time.

Case studies can also be used to provide qualitative information on results from similar projects. More quantitative approaches involve computer models evaluating changes in cost of production and the resulting impacts on economic growth and input-output models that look at indirect and induced effects in the context of the available labor and facility resources in addition to other job losses that might occur as a result of a transportation investment.

Transit Cooperative Research Program (TCRP)

TCRP Report 78: Estimating the Benefits and Costs of Public Transit Projects: A Guidebook for Practitioners, Transportation Research Board, National Research Council, 2002.

The TCRP report describes the importance of measuring user benefits separately for different income classes of users in order to address equity issues. The report highlights how travel time value varies with the type of activity involved and qualitative values such as comfort are implicit in the time value calculation. The report provides different values based on wage for in-vehicle (local, intercity, & business) and excess (waiting/transfer time for business & non-business) wait times. Travel time is evaluated by mode, assigning different factors for auto and truck users. If all factors cannot be included, the report specifies that the relative benefit-cost ranking of these projects can still be relatively accurate, even if the absolute benefit-cost performance is uncertain.

When assessing vehicle usage and operating costs, the TCRP report suggests measuring transit user costs separate from auto, truck, and non-motorized user costs. The two main components used in this evaluation are the monetary costs and travel time value. Transit costs are primarily evaluated based on fares for adults, linked and unlinked trips, peak periods, and trip distance and transfers. Other monetary values can be assigned based on incidents, fatalities, injuries, and property damage. For cars, costs such as maintenance, insurance, depreciation, and licensing are typically included. For trucks, cargo inventory costs can also be taken into account. The report attempts to measure the value non-transit users assign for the ability to use transit when auto use is not possible due to bad weather, a broken down vehicle, increases in fuel prices and other operating costs. A price for the automobile trip is assumed based on auto operating costs and travel time value. A volatility factor is assigned at a certain percentage range of the original price of the trip. An exercise price for a transit trip is assumed based on fares, transit travel time value, and other characteristics. Then the frequency with which transit might be optionally used can be estimated at a certain number of trips per year and value assigned.

Environmental savings are separated into benefits related to air quality, water quality, and noise. The report targets particular pollutants of concern and outlines procedures for measuring air quality costs. The costs are based on regional vehicular volumes and speeds and the emission factors for each vehicle type. Costs are assigned based on impacts to health, visibility, and agricultural crops. For water quality, low and high cost estimates are provided related to storage tank leakage, larger spills, and runoff. Noise levels are expressed in cents per passenger mile for single-occupant vehicles, buses, and rail in the peak and off-peak hours. The costs also depend on the density of the surrounding area and the type of land use. Noise impacts can be calculated by observed vehicle speeds, acceleration rates and operating weights. Research is cited that correlates noise levels with economic impacts, finding that each decibel of noise above a specific threshold (50 dBA) reduces the value of a home by 0.2-1.3 percent.

Recognizing that land development impacts are highly dependent on local policy and market, the report advocates the use of qualitative methods and allocation rules, as well as multiple forms of statistical, economic, and GIS-based models. A more firm grip on the changes that could occur are developed by looking at existing land uses and location in combination with plans,

regulations, expert knowledge, and modeling. The report ranks different forms of transportation projects according to the potential land use impact and the factors involved in forwarding the formation of land use changes. Drawing from the report, changes in property value are to be assessed according to public and private capital costs and operating costs. The report notes that a transit facility must be located in areas with supportive land use codes, streamlined permitting, lower or adjusted impact fees, available land capacity, and existing infrastructure to support increases in density.

The ability of transit to enhance employment accessibility is measured by how well the transit facility will alleviate the special mismatch between the demand for certain labor skills and the locations where labor with those skills reside. The report advocates conducting a survey of transit riders to gather information on the use of the transit system for commuting, auto ownership, and income. The survey can then be used to calculate the number of people using a system to travel to work who otherwise would not be able to do so without the system. This method cannot be applied to an analysis of systems that have not yet been developed.

Victoria Transport Policy Institute (VTPI)

Evaluating Public Transit Benefits and Costs, Todd Litman, Victoria Transport Policy Institute, July 23, 2004.

The VTPI report advocates valuing travel time based on one-quarter to one-half of the wage rate. A higher cost is assigned to drivers than passengers due to the added stress they bear. The report also indicates that travel time costs increase due to congestion or unexpected delays, uncomfortable passenger conditions, longer trips, waiting for transfers, higher income or employment status, and personal preferences. These values are expressed using the recommendations provided in *Box 1* below. The VTPI report indicates that automobile costs should include policing, emergency services, street lighting, and publicly subsidized parking. These costs are added together and a price is provided per passenger mile. External costs such as crash risk imposed on other road users are considered and numbers are provided for rural and urban conditions in the peak and off-peak.

Box 1 **Recommended Travel Time Values** ("Travel Time Costs," Litman, 2003)

	Travel Time Values
Commercial vehicle driver	Wage rate plus fringe benefits
Personal vehicle driver	50% of current average wage
Adult car or bus passenger	35% of current average wage
Child passenger under 16 years	25% of current average wage

Congestion increases driver's travel time costs by the following amounts according to roadway Level of Service (LOS) ratings:

LOS D: multiply by 1.33 LOS E: multiply by 1.67 LOS F: multiply by 2.0

Under unpleasant or insecure conditions (waiting for transit in a dirty and insecure area, or walking on busy roads that lack sidewalks), time spent walking, cycling and using transit has two or three times the cost of time spent traveling, depending on the degree of discomfort.

This box summarizes travel time values, taking into account the additional stress and therefore higher costs associated with driving in congestion, and for transit travelers who experience unpleasant or insecure conditions.

Environmental savings are discussed through the evaluation of energy conservation, air emissions, noise, and water pollution. Fuel consumption numbers are provided, citing a 2002 report by APTA on the average miles per gallon and BTU per passenger mile by transportation mode. For air emission impacts, APTA numbers are provided for Carbon Dioxide (CO) and Nitrogen Oxides (NOx) by mode. Dollar values are assigned to pollution according to EPA models that predict the impacts of transport energy conservation and emission reduction strategies. Potential land use changes can be evaluated in terms of the amount of land used for the transit facility, changes to development patterns and accessibility, emergency service response times, and vehicle ownership. These land use changes are generally evaluated based on how well the transit facility will fulfill community land use objectives or other planning goals.

American Public Transit Association (APTA)

- *Transportation Spending and Economic Growth: The Effects of Transit and Highway Expenditures*, David Alan Aschauer, September 1991.
- *The Benefits of Public Transportation: An Overview*, Reichman Frankle, Inc. American Public Transportation Association, 2002.
- *The Benefits of Public Transportation: Essential Support for A Strong Economy*, American Public Transportation Association & Public Transportation Partnership for Tomorrow, 2004.

APTA has reported on the benefits of transit for decades. The 1991 report measures the extent transportation expenditures would result in increased economic productivity. The report evaluates whether transportation spending raises the pace of private capital accumulation resulting in increased productivity. An analogous formula is used to identify the discounted value of the increased transportation spending in order to evaluate whether net benefits that are sharply negative in the first few years result in a gradual rise over time as the positive effects on economic growth begin to accumulate. This type of analysis is used to evaluate whether the spending is justified based on the benefits incurred over the life of a particular project.

The more recent reports reference a number of successful examples from around the U.S. For example, the extent of travel time savings is documented by referencing specific examples from Atlanta, San Francisco, Minneapolis, and New York City. The report cites a recent study that estimates a reduction in roadway related costs by as much as $1 billion to $1.7 billion per year. These costs include traffic enforcement, emergency services, and right-of-way acquisition. Another example indicates that Atlanta's MARTA system saved $2.2 billion from 1980-1994 by providing motorists with a public transportation alternative.

Environmental savings are addressed by highlighting the high emission levels from passenger cars and light trucks. The report indicates that urban runoff contributes to environmentally impaired ocean shorelines, estuaries, and lakes. In contrast, the report indicates the advantages of transit based on the lower levels of carbon monoxide, hydrocarbons, nitrogen oxides, and improved fuel efficiencies. APTA advocates transit investment as a method of revitalizing business districts and activity centers, citing examples from around the country where transit is purported to have contributed to intensive financial investments in office buildings and cultural or entertainment facilities. In addition, the report suggests that the public transportation industry generates up to a 6-to-1 net return on investment citing examples where the taxable value of properties near fixed transit systems have been found to have increased. The report also measures how transit preserves small urban and rural communities by reducing auto use through the provision of shuttle services, dial-a-ride service, and other forms of inter-modal access.

The APTA reports measures how transit creates and sustains jobs based on $10 million of investment and provides examples where monetary benefits have been reported as a result of improved job access. Because APTA is primarily an advocacy organization, some of the more recent reports have been criticized. Critics charge that APTA figures often allocate too much of the overall benefit to a transit investment without controlling for other potential influences or that they focus primarily on areas where transit has been particularly successful.

Summary of Findings

The information from national reports and studies were reviewed to help determine appropriate methods and data sources for conducting the evaluation of economic benefits in the central Puget Sound region. The research revealed that both direct and in-direct economic benefits of a regional transit system are of compelling interest to decision-makers from other U.S. regions. Positive influences that can be directly attributed to transportation system improvements are often discussed as direct benefits. Direct benefits can include travel time saving and vehicle operating cost reductions. Indirect benefits represent how the direct benefits are capitalized by individuals in the physical environment, such as land use changes and increases in property values. Direct benefits are generally more easily quantified than indirect benefits and they are generally given more attention in the national studies. The Regional Council report draws from national studies, such as the NCHRP and TCRP reports summarized previously. Regional benefits were estimated using methods that were modified to reflect the scope of this analysis. The scope is limited by a number of variables, such as a lack of available technical data on detailed alignments and limited qualitative data from businesses and households impacted by the proposed high capacity transit system.

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