POTENTIAL ECONOMIC IMPACTS OF PROPOSED TRANSPORTATION SYSTEM IMPROVEMENTS

Route 29 Corridor Improvement Project—Phases II & III EIS

Technical Memorandum No. 4:
A Methodology for Measuring the Economic Value of Proposed Transportation Improvements

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Introduction

The process of measuring economic value attributed to investment in transportation system improvements is complex, and controversial. Often, both politicians and the public insist that transportation improvements automatically lead to increased growth and development. In some cases, this link between investment and development is cited as the rationale for investment. In other cases, this supposed cause and effect relationship is used as an argument for maintaining the status quo. In fact, experience indicates that the link between investment and development is far from simple. The causes of growth and development are numerous, and rarely automatic.

Transportation alternatives that improve accessibility and mobility within a region contribute to growth and development, but other factors are often at least as important. In particular, in mature urban areas, an extensive system of existing roads, highways, and rail facilities contributes to the attractiveness of an area as a center for production and distribution of goods and services. What is often the limiting factor for accommodating new development is the capacity of the existing system within a context of market demand—the level of demand for new products and services. Market demand increases because of increasing population and because of an increase in the ability of producers to reach a broader economic base. Market demand, however, is also the result of numerous factors that characterize this increasing population base. These factors include the type of existing development and need for additional support, demand for final products, availability of labor force, cost of production and operation, relationship with land use plans and the agencies that administer those plans, fiscal constraints and opportunities, quality of life, and others. How these factors compare helps to define competition among different locations where new industry can locate. Where market demand exists, as evidenced by development trends in coordination with opportunities for expansion, capacity of the transportation system to accommodate that demand can become a critical issue.

The discussion that follows is in two parts. Part One describes a method for measuring the relative economic value of proposed transportation system improvements based on the concept of change in capacity. This method is designed to compare the economic value of different alternatives. Using this approach, we measure economic value based on the interaction of market conditions and the ability of the transportation system to accommodate potential change. The discussion begins with a definition of economic value. Building on that definition, we outline a procedure to measure how changes in system capacity can affect economic value in the selected region.

Part Two describes an application. For each step we illustrate the techniques used to measure economic value. Beginning with a discussion of background conditions, the application proceeds through a review of long-term economic valuation. The next section on fiscal impacts illustrates the methods used to measure potential benefits for specific jurisdictions in the study area. The third section on construction describes the process used to measure short-term economic impacts. As a result, the multi-step valuation approach measures economic value of each proposed transportation system improvement alternative encompassing long- and short-term effects as well as fiscal impacts on local jurisdictions.

I. Economic Valuation—The Process

To measure economic impacts of proposed improvement projects on a community, we need to define elements that are characteristic of growth and development. Where possible, we must be able to define these elements in quantitative terms, even when they represent changes in qualitative conditions. Further, the definition of these quantitative elements must be reproducible. Different audiences must be able to understand and reproduce the results so that measurements themselves are not the source of controversy. These measurements should also be linked to the results of public policy decisions so that both the public and their political representatives can understand the ramifications of alternative development strategies. Therefore, the critical first step in defining a method for measuring economic impacts is to make the connection between measures of growth and development and public policy.

Economic Impact Measures

There are a series of factors we can use to measure economic impacts. The first of these, and the most direct, is *changes in population and employment.* Changes in population and employment are basic measures of growth and development. Both are directly linked. Growth in employment brings new households (i.e. population) to a region, and growth in population generates demand for additional jobs. People relocate to or within a region based primarily on employment opportunities. When demand for labor increases, the number of households and total population increase concurrently. New households also demand additional services, which in turn generates a demand for additional employment. This spiraling increase represents what is known as the *multiplier effect*. New employment creates a need for additional services that, in turn, creates a need for additional employment. Increases in population also create a need for additional services that require additional service employment.

Associated with employment are *wages and salaries*. Wages and salaries in the form of household income are used to purchase goods and services. Wages and salaries are paid to employees on the basis of the value of goods and services received. Therefore, if we can measure the related change in employment, then we can also measure the change in wages and salaries in a defined market area. In addition, based on income, households and businesses pay taxes to state and local jurisdictions. These taxes are used by the public sector to purchase goods and services and to pay public sector employees. Therefore, taxes also generate employment and create value in the study area. Other sources of income resulting from investments and from sale of products and services include profit, dividends, and interest. The combination of all of these factors, including wages, state and local taxes paid by households, dividends, interest, and profit, is known as *value added*. Value added represents the total sum of value created by business and household expenditures in the region or study area and, as such, is an effective measure of economic activity. In economic terms, value added is also known as *gross regional product*. If we can link the capacity for change in employment and value added to changes in the transportation system capacity, then we can measure the economic value of alternative transportation system investments.

Market Analysis and Public Policy

Economic growth and development takes place within a framework. Because there are so many factors that contribute to growth, it is often possible only to measure the results of those factors based on past experience. Past experience then provides a basis for predicting future growth, if similar conditions prevail. It is not possible to predict all of the factors that affect growth. Human conditions and psychology often have as much impact on growth as investment factors. What we can do is predict what might happen based on previous experience. This process is known as the baseline conditions analysis. It shows what would

happen if similar conditions continue—whatever those conditions might have been in the past. Using this method, we can estimate employment and population growth in the study area toward a future target date.

The baseline conditions analysis, by its nature, assumes that infrastructure capacity exists to accommodate projected growth on the order of what has occurred previously. If that capacity exists and if we can measure that capacity in terms of its ability to accommodate additional households and businesses, then we can link projected growth to future changes in the infrastructure.

In highly urbanized areas, one of the most sensitive infrastructure components is the transportation system. Transportation system capacity problems are often visually apparent through daily levels of traffic congestion during peak hours of travel. Ability in the future to accommodate growth is directly related to the baseline population and employment projections and the continued availability of land for both residential and commercial development. Availability of land for development is a function of approved land use plans within each jurisdiction within the study area. These land use plans are the link between public policy decisions and the economic factors that measure demand for new employment.

If existing market conditions support additional growth, then new businesses and residential uses look for land on which to build. If land is available according to existing land use plans, then jurisdictions have the capacity to accommodate new development subject to availability of infrastructure capacity. Assuming that water and sewer capacity exists, then the next most important infrastructure component required is the transportation system. As residential and commercial development occurs, more and more trips are generated. At a certain point, the existing highways and rail systems cannot operate efficiently because of high levels of congestion. This problem occurs both with people and freight, causing different effects on the existing regional markets.

When high levels of congestion inhibit growth, then the ability to accommodate new development changes. Projections generated through baseline conditions analysis are no longer valid. As a result, growth slows. If demand for growth and development continues, then new and expanding businesses and associated households look for other places to locate. In a positive environment, the decision to accommodate additional growth is often a conscious application of land use and zoning regulations. This decision can then create a need for increased capacity of the infrastructure system. Without that decision, an alternative is to limit future development.

Transportation Model

The next major component of the process is the traffic/transportation model. We need to link land use and development options with possible changes or improvements to the transportation system. That link is accomplished through the application of a traffic-generation model. The traffic model uses existing and proposed growth and development to project total traffic throughout the system. This projection uses average trip generation rates to estimate the number of trips that can be expected for each particular type of land use. Trip generation rates are based on average figures derived through experience and then "calibrated" to the particular system. Calibration means varying the estimated rates to match the actual traffic loads experienced on the transportation network within the study area.

Once the model is calibrated for use on the existing network, projected changes that are proposed as part of the alternatives analysis are used to estimate total future traffic. These changes are based on population and employment projections that generate development. Development is distributed throughout the study area based on existing land use plans that show general type of use and land availability. Future development is estimated by zone throughout the study area. These zones are known as TAZs—Traffic Analysis Zones.

Using this approach, the traffic model provides a necessary link between proposed improvements to the system and potential changes in land use and development. Changes in development are directly related to changes in employment attracted to the region because of market demand—growth in population, employment, and productivity.

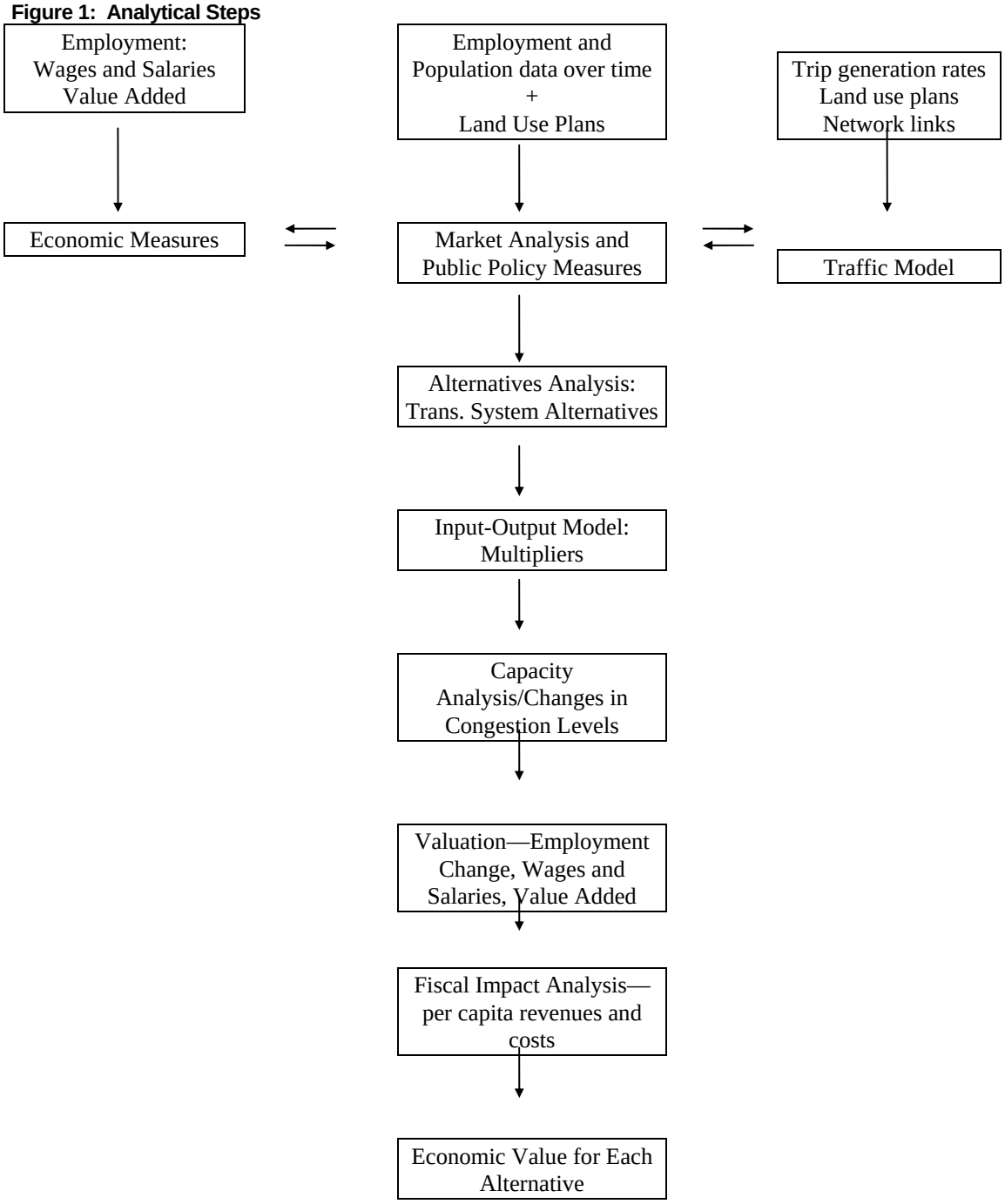
Measuring Economic Impacts

This process uses the three components together to measure the value of proposed improvements to the transportation system: population and employment analysis, the market analysis and baseline conditions projection coupled with existing land use plans, and the application of the transportation model. The population and employment analysis creates a picture of existing conditions. The market analysis and baseline conditions projection shows what development can occur in the region if existing demand continues and if infrastructure capacity (including the transportation system) exists. This analysis also takes into account public policy toward growth and development as characterized by existing land use plans. The traffic model indicates the level of impact on the transportation system if projected development occurs in the areas designated for growth by the existing land use plans.

The steps used in estimating the potential economic value of proposed transportation system improvements are summarized on the following diagram. In general, the process uses a capacity estimate for the existing transportation system to measure how much of an impact increased development will have on baseline conditions, and how each of the proposed improvements might affect that capacity. If a proposed improvement increases capacity of the system, then we have created an opportunity to accommodate already-projected employment and population growth at better service levels (e.g., reduced congestion). Improving levels of service is measured in comparison to what might occur under the no-build alternative with the same projected growth and development. Using this approach, the change in employment and population represented by the improved levels of congestion over that associated with the no-build alternative is the basis for calculating economic value.

The role of the jurisdiction does not change from its current responsibility of overseeing future growth and development. What this process can do is provide a measure of the increased ability of the system to absorb growth within the guidelines established by existing land use and zoning plans. Using capacity analysis to measure the associated economic value does not guarantee future development if it is desired, nor does it prevent future growth if it is otherwise approved. What this process can do is demonstrate the impact on congestion if growth and development are allowed to occur without the necessary capacity. The change in the capacity of the system is the basis on which economic value is measured.

Figure 1: Analytical Steps



Step One: Congestion Analysis

The first step is to identify the method for measuring congestion. One approach is to define the baseline conditions without any improvements and measure the vehicle miles of travel (VMT) or vehicle hours of travel (VHT) at a particular level of service or worse. For example, if projected no-build conditions create capacity problems at particular locations, then these locations become the basis for comparison among improvement alternatives. Each proposed transportation system improvement alternative will increase the capacity of the network and decrease the VMT or VHT at unacceptable levels of service. These improvements can address all components of the transportation system, including highway, rail, pedestrian, or bus. We use the traffic models to help measure this added capacity and the resulting changes in VMT or VHT at unacceptable levels of service.

For each of the improvement alternatives, we need to measure the change in levels of congestion and the resulting changes in VMT or VHT. Some alternatives will provide better results than others. The product of this step in the valuation process is a table that shows how much improvement results from each of the proposed system improvements.

Step Two: Resulting Change in Employment

We can use the existing land use plans to test how much system capacity changes with each proposed alternative. As indicated, the traffic model uses trip generation rates applied to development within Traffic Analysis Zones (TAZs) to determine how many new trips occur as a result of new development. For the baseline condition alternative (the no-build scenario), if we decrease the employment in those TAZs that have the highest concentration of new development until the VMT or VHT at critical links is the same as that generated by a proposed improvement package, then we have an estimate of the added capacity. What is even more important, we now have a measure of that capacity improvement in units of new employment. By carrying out the traffic model tests, we can show how much employment would have to be constrained in the no-build alternative to create the same conditions as that attributed to each of the proposed alternatives. This level of constraint is measured in number of jobs.

The output of this step is another table. This table will show the number of additional jobs that would have to be eliminated in the no-build alternative to create the same level of congestion as that generated by each of the proposed improvement packages. This process assumes that only those alternatives that improve capacity are desirable. Other alternatives that make the situation worse, would be eliminated.

This analysis does not mean that building the alternative will create a new level of employment. Instead, it means that the proposed alternative *has the ability* to improve the capacity of the system with an improved level of congestion over that attributed to the no-build alternative. Under the no-build option, we would have to remove this level of employment from the area served by the system to equal the reduced levels of congestion attributed to that specific improvement package.

Step Three: Valuation

Measuring the improvement associated with each alternative in number of jobs provides a basis for calculating the economic value of the proposal. For this step in the process, we use an input-output model to determine the value of the change in employment associated with each proposed alternative. As indicated previously, this value is measured in terms of increased wages and salaries, total output, and value added.

We use the input-output model to estimate value added and wages and salaries associated with changes in employment. This total increase includes direct, indirect, and induced changes. The total value added to the regional economy is a dollar measure of the increased ability of the area to accommodate already-projected growth and development. Already projected growth is a result of the baseline conditions market analysis.

Step Four: Fiscal Impacts

New growth and development generates revenues. But there are also costs. This step in the process examines how local jurisdictions fare as a result of the trade-off between revenues and costs. New regional income and product development generate tax revenues to state and local jurisdictions. With this added income, these same jurisdictions must pay for the additional services new households and businesses require—schools, roads, libraries, water and sewer, police, fire, and other necessary services. The quality of these services, in turn, is one of the significant location factors that attracts new industry to the region. The ability to generate more income than expenses is critical to the economic health of the region.

To accomplish this step, we work with data from local and state jurisdictions to calculate per capita costs and revenues using budget data over several years. This information is used to project future income and expenses as a function of projected population and employment growth. The long-term relationship between costs and revenues is the foundation on which fiscal impacts are measured.

Summary

What will we accomplish as a result of this analysis? We will be able to show the economic value (or cost) for each proposed alternative in comparison to the no-build alternative, and we will have measured this economic value or cost in terms of the capacity of the transportation network to absorb a projected *potential* change in employment. This potential change in number of jobs has value, measured in terms of wages and salaries and total value added to the regional economy. The process will also allow us to calculate additional income to state and local jurisdictions as a result of new tax revenues offset by the costs associated with increased population and new businesses. The result is a measure of the comparative value of each transportation system improvement alternative.

It is important to remember that providing additional capacity does not necessarily mean that new development will occur. Actual growth and development are the result of a complex set of factors that are important to new industry. In addition, the approach outlined in this description examines the ability to absorb already-projected growth and development consistent with existing land use and zoning plans. The consistency requirement represents the input of and local control by the affected jurisdictions. As a result, the absorption capability and the estimated relative value of each of the proposed transportation system improvement alternatives are based on the effects of increased capacity of the resulting system.

II. Methodology—An Application

As indicated, the valuation methodology brings together several facets of economic analysis. The baseline conditions and market analysis use existing population and employment data to generate growth projections. This step also uses four-digit SIC code employment and income data to determine localized economic strengths and to help identify strong economic sectors. The strength of individual sectors is the link between growth and multiplier effects. As part of this stage in the analysis, we also use location-quotient calculations to help determine the *relative* strengths of economic sectors in comparison to the broader region. Those sectors which exhibit relative strength are considered "export" sectors—sectors in which growth and development will most logically occur.

Baseline Conditions Analysis

The baseline conditions analysis provides the standard against which proposed improvements are measured. If we can predict what might happen without any change to the supporting transportation system, then we can begin to measure how improvements will impact future growth. If we can measure these impacts in terms of a change in employment capacity of the transportation network and the accepted land use plans, then we can place a value on the proposed improvements in comparison to the no-build alternative.

Employment and population data used in this phase is available from the US Bureau of Economic Analysis through the Regional Employment Information Service.[1] Data is currently available for population, employment, and income through 1996 and is updated at least annually. To prepare the baseline analysis and projections through 2020, we use 1980 through 1996 data by two-digit SIC code. Table 1 illustrates the type of data collected using the Route 29 Corridor Study area as an example.

Table 1: Population and Employment Data—Route 29 Corridor, Virginia

	1980	1981	1982	1983	1984	1985	1986	1987	1988
Population (number of persons)	414,771	417,587	418,526	418,873	420,438	422,813	422,628	424,787	428,372
Wage and salary disbursements	2,199,232	2,389,367	2,474,460	2,677,768	2,921,087	3,090,584	3,293,314	3,558,899	3,821,043
Total full- and part-time employment	217,771	217,178	215,147	217,694	224,961	228,976	233,436	242,264	245,980
Wage and salary employment	189,652	188,724	185,230	187,715	193,784	195,908	198,419	205,513	211,770
Proprietors' employment	28,119	28,454	29,917	29,979	31,177	33,068	35,017	36,751	34,210
Farm proprietors' employment	7,215	7,325	7,404	7,602	7,237	6,955	6,471	6,126	5,961
Nonfarm proprietors' employment	20,904	21,129	22,513	22,377	23,940	26,113	28,546	30,625	28,249
Farm employment	9,577	9,734	9,790	10,171	9,532	9,201	8,214	7,673	7,650
Nonfarm employment	208,194	207,444	205,357	207,523	215,429	219,775	225,222	234,591	238,330
Private employment	169,669	169,385	166,968	169,430	177,316	181,027	185,926	194,608	197,760
Ag. serv., forestry, fishing, and other	1,006	1,079	1,184	1,202	1,311	1,438	1,544	1,604	1,649
Mining	356	385	357	319	405	445	426	506	577
Construction	10,607	9,822	9,298	9,894	11,278	12,373	13,747	15,070	15,832
Manufacturing	62,059	61,718	58,193	57,751	58,931	56,372	55,231	56,130	55,119
Transportation and public utilities	6,946	6,996	6,869	7,150	7,481	7,617	7,862	7,967	7,651
Wholesale trade	5,983	5,962	5,849	6,057	6,347	6,604	6,891	8,042	7,710
Retail trade	29,933	29,709	29,855	30,837	32,783	34,398	35,186	37,417	40,221
Finance, insurance, and real estate	12,908	12,789	12,828	12,358	12,863	13,330	14,259	14,102	14,036
Services	39,844	40,898	42,524	43,860	45,914	48,447	50,777	53,532	54,859
Government and government enterprises	38,525	38,059	38,389	38,093	38,113	38,748	39,296	39,983	40,570
Federal, civilian	2,198	2,205	2,218	2,135	2,171	2,195	2,245	2,308	2,361
Military	1,916	1,950	2,178	2,155	2,180	2,270	2,396	2,453	2,469
State and local	34,411	33,904	33,993	33,803	33,762	34,283	34,655	35,222	35,740
State	19,305	19,473	19,498	19,605	19,386	19,483	19,777	20,010	19,971
Local	15,106	14,431	14,495	14,198	14,376	14,800	14,878	15,212	15,769

[1] The REIS is maintained by the Weldon-Cooper Center of the University of Virginia. Most recent update was June, 1998.

	1989	1990	1991	1992	1993	1994	1995
Population (number of persons)	432,424	437,624	440,140	444,374	447,515	451,631	453,868
Wage and salary disbursements	4,077,644	4,272,682	4,343,686	4,569,905	4,848,125	5,053,686	5,286,730
Total full- and part-time employment	253,316	255,797	252,741	253,924	261,298	265,337	268,968
Wage and salary employment	217,651	217,738	214,744	216,391	223,461	227,507	230,531
Proprietors' employment	35,665	38,059	37,997	37,533	37,837	37,830	38,437
Farm proprietors' employment	5,896	5,760	5,625	5,526	5,613	5,673	5,797
Nonfarm proprietors' employment	29,769	32,299	32,372	32,007	32,224	32,157	32,640
Farm employment	7,198	7,206	7,279	7,062	6,962	6,969	7,303
Nonfarm employment	246,118	248,591	245,462	246,862	254,336	258,368	261,665
Private employment	204,545	206,688	203,122	204,197	210,547	214,312	217,387
Ag. serv., forestry, fishing, and other	1,747	1,771	1,209	1,559	1,863	2,057	2,179
Mining	526	375	259	291	288	287	348
Construction	16,333	16,302	14,940	14,788	15,412	16,489	17,246
Manufacturing	55,829	54,658	52,475	52,044	52,341	52,219	51,653
Transportation and public utilities	8,098	8,297	7,916	7,967	8,294	8,333	8,263
Wholesale trade	8,057	7,521	7,722	7,570	7,822	8,129	8,416
Retail trade	42,176	42,775	41,553	41,764	42,614	44,404	45,635
Finance, insurance, and real estate	14,749	15,390	15,436	15,179	15,396	15,692	15,390
Services	57,030	59,338	60,619	62,495	65,876	66,003	67,549
Government and government enterprises	41,573	41,903	42,340	42,665	43,789	44,056	44,278
Federal, civilian	2,396	2,387	2,341	2,368	2,373	2,391	2,751
Military	2,502	2,583	2,529	2,400	2,365	2,252	2,070
State and local	36,675	36,933	37,470	37,897	39,051	39,413	39,457
State	20,595	20,604	20,871	20,976	21,660	21,356	21,168
Local	16,080	16,329	16,599	16,921	17,391	18,057	18,289

The following charts illustrate corridor employment distribution over time. Figure 2 shows distribution by total annual employment. Figure 3 shows sector employment distribution annually.

Figure 2: Yearly Employment Distribution

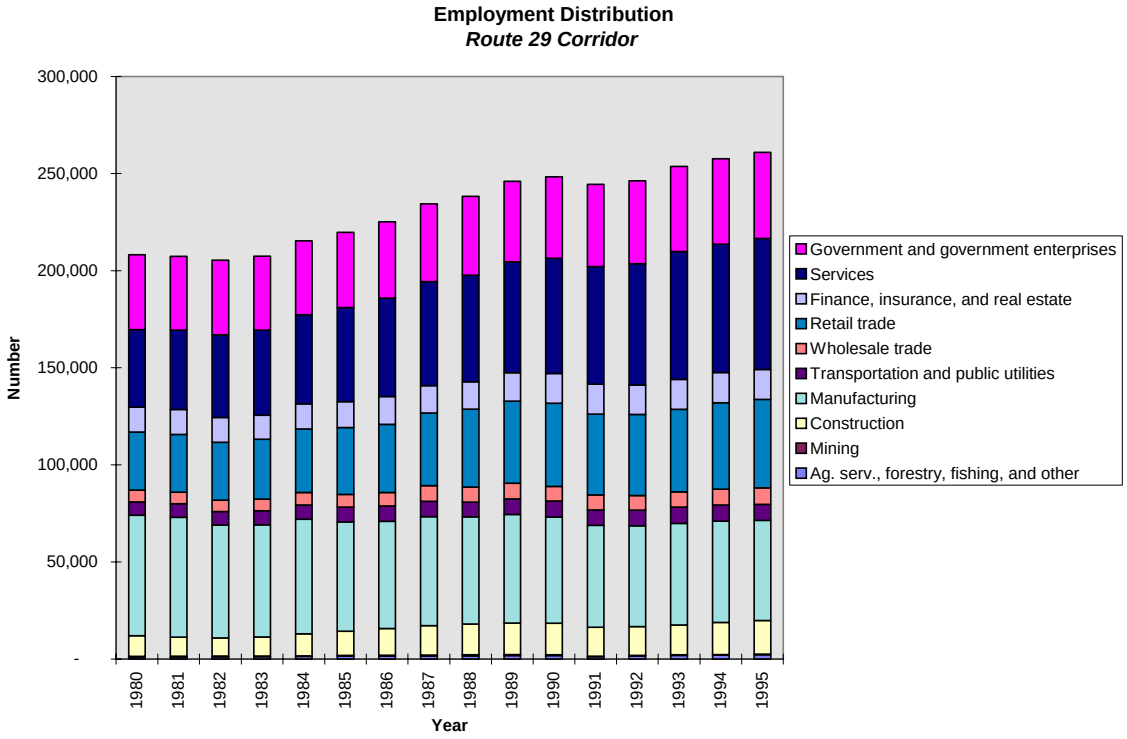


Figure 3: Employment Distribution by Sector

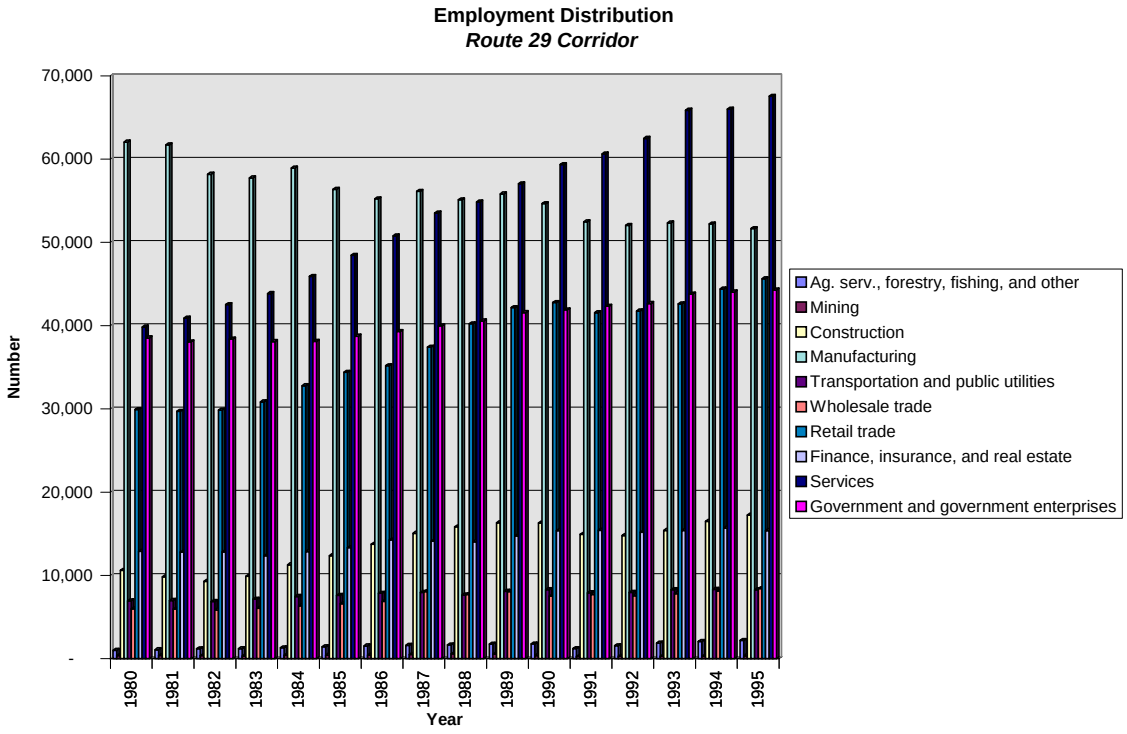
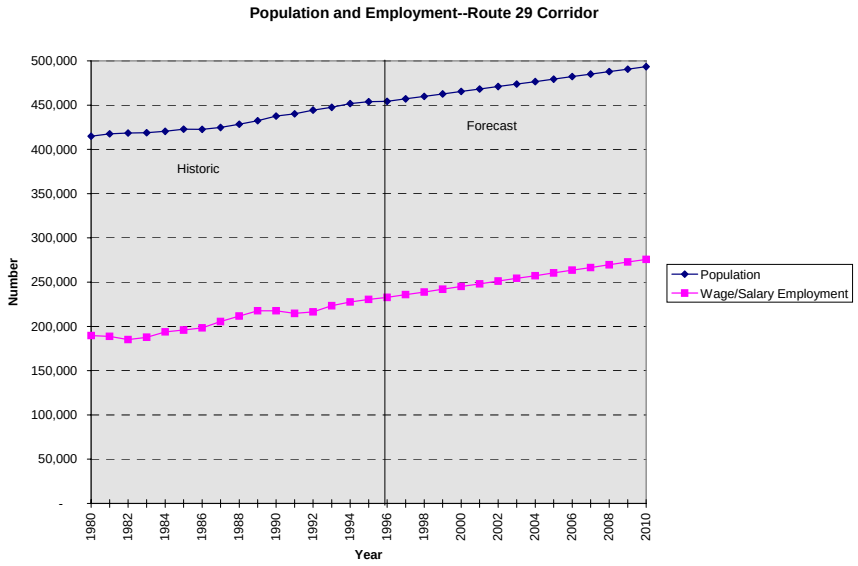


Figure 4 illustrates projected growth and development for the corridor through a target year of 2020. Projections include population, employment, and several individual employment sectors.

Figure 4: Projected Growth and Development



Source: The SGM Group, Inc., US Bureau of Economic Analysis

We use multi-variable regression analysis to project baseline population and employment. Table 2 illustrates the data array used in the regression analysis.

Table 2: Economic and Demographic Analysis—Route 29 Corridor

Year	Population	Wage/Salary Employment	Wages & Salaries (1,000$)	Number of Employees/ Population	W&S per Employee	Man. Employ.	Man. as % of Total Employ	Retail Trade Employment	RT as % of Total Employ
1980	414,771	189,652	$2,199,232	45.72%	$11,596	62,059	32.72%	29,933	15.78%
1981	417,587	188,724	$2,389,367	45.19%	$12,661	61,718	32.70%	29,709	15.74%
1982	418,526	185,230	$2,474,460	44.26%	$13,359	58,193	31.42%	29,855	16.12%
1983	418,873	187,715	$2,677,768	44.81%	$14,265	57,751	30.77%	30,837	16.43%
1984	420,438	193,784	$2,921,087	46.09%	$15,074	58,931	30.41%	32,783	16.92%
1985	422,813	195,908	$3,090,584	46.33%	$15,776	56,372	28.77%	34,398	17.56%
1986	422,628	198,419	$3,293,314	46.95%	$16,598	55,231	27.84%	35,186	17.73%
1987	424,787	205,513	$3,558,899	48.38%	$17,317	56,130	27.31%	37,417	18.21%
1988	428,372	211,770	$3,821,043	49.44%	$18,043	55,119	26.03%	40,221	18.99%
1989	432,424	217,651	$4,077,644	50.33%	$18,735	55,829	25.65%	42,176	19.38%
1990	437,624	217,738	$4,272,682	49.75%	$19,623	54,658	25.10%	42,775	19.65%
1991	440,140	214,744	$4,343,686	48.79%	$20,227	52,475	24.44%	41,553	19.35%
1992	444,374	216,391	$4,569,905	48.70%	$21,119	52,044	24.05%	41,764	19.30%
1993	447,515	223,461	$4,848,125	49.93%	$21,696	52,341	23.42%	42,614	19.07%
1994	451,631	227,507	$5,053,686	50.37%	$22,213	52,219	22.95%	44,404	19.52%
1995	453,868	230,531	$5,286,730	50.79%	$22,933	51,653	22.41%	45,635	19.80%
1996	454,306	232,805	$5,455,960	51.24%	$23,436	50,180	21.55%	47,358	20.34%
1997	457,094	235,876	$5,664,324	51.60%	$24,014	49,518	20.99%	48,496	20.56%
1998	459,882	238,947	$5,872,688	51.96%	$24,577	48,856	20.45%	49,635	20.77%
1999	462,670	242,018	$6,081,051	52.31%	$25,126	48,195	19.91%	50,773	20.98%
2000	465,458	245,089	$6,289,415	52.66%	$25,662	47,533	19.39%	51,912	21.18%
2001	468,245	248,160	$6,497,778	53.00%	$26,184	46,871	18.89%	53,050	21.38%
2002	471,033	251,231	$6,706,142	53.34%	$26,693	46,209	18.39%	54,189	21.57%
2003	473,821	254,302	$6,914,505	53.67%	$27,190	45,548	17.91%	55,327	21.76%
2004	476,609	257,373	$7,122,869	54.00%	$27,675	44,886	17.44%	56,466	21.94%
2005	479,397	260,444	$7,331,232	54.33%	$28,149	44,224	16.98%	57,604	22.12%
2006	482,184	263,515	$7,539,596	54.65%	$28,612	43,562	16.53%	58,743	22.29%
2007	484,972	266,586	$7,747,959	54.97%	$29,064	42,900	16.09%	59,881	22.46%
2008	487,760	269,657	$7,956,323	55.28%	$29,505	42,239	15.66%	61,020	22.63%
2009	490,548	272,728	$8,164,686	55.60%	$29,937	41,577	15.24%	62,158	22.79%
2010	493,336	275,799	$8,373,050	55.91%	$30,359	40,915	14.84%	63,296	22.95%
2011	496,123	278,870	$8,581,413	56.21%	$30,772	40,253	14.43%	64,435	23.11%
2012	498,911	281,941	$8,789,777	56.51%	$31,176	39,592	14.04%	65,573	23.26%
2013	501,699	285,012	$8,998,140	56.81%	$31,571	38,930	13.66%	66,712	23.41%
2014	504,487	288,084	$9,206,504	57.10%	$31,958	38,268	13.28%	67,850	23.55%
2015	507,275	291,155	$9,414,867	57.40%	$32,336	37,606	12.92%	68,989	23.69%
2016	510,062	294,226	$9,623,231	57.68%	$32,707	36,945	12.56%	70,127	23.83%
2017	512,850	297,297	$9,831,595	57.97%	$33,070	36,283	12.20%	71,266	23.97%
2018	515,638	300,368	$10,039,958	58.25%	$33,426	35,621	11.86%	72,404	24.11%
2019	518,426	303,439	$10,248,322	58.53%	$33,774	34,959	11.52%	73,543	24.24%
2020	521,214	306,510	$10,456,685	58.81%	$34,115	34,298	11.19%	74,681	24.36%
Rate of Growth									
1980-1997	0.57%	1.29%	5.72%		4.38%	-1.32%		2.88%	
1998-2020	0.57%	1.14%	2.66%		1.50%	-1.60%		1.87%	

Existing data is available for 1980 through 1996. Projections are from 1997 through 2020. Using this method can create a potential conflict if local or regional jurisdictions have also generated growth and development projections. If the projections are comparable, then the dual methods are a check on the estimates. If the projections are widely disparate, then a process of reconciliation is necessary. Since the projections used in this effort are based on extending existing conditions, it is not unusual to understate future growth in highly active markets or overstate growth in declining markets. Discussions with those agencies responsible for long-range planning can help to resolve conflicts.

Other techniques are also used to understand the local economy and provide a basis for accepting the demographic and employment projections. We use the same BEA data to prepare location quotients measuring relative strengths of study area economic sectors. Those sectors that demonstrate location quotients greater than 1.0 are relatively strong, acting as "export" industries. These sectors, especially if the location quotients are increasing over

time, are generally exporting services or products to the surrounding areas. As a result, they represent potential opportunities for future growth. If these sectors are reasonably dependent on transportation systems, either for industrial purposes or for labor force accessibility, then system improvements can help contribute to realizing future growth and development potential.

Table 3 illustrates a shift-share distribution analysis for Campbell County (including the City of Lynchburg) as well as for the corridor study area used to measure potential economic conditions affecting proposed transportation system improvements. These data show the sources of growth for 2-digit SIC economic sectors, including construction, manufacturing, transportation, finance, services, retail, and government.

Table 3: Shift-Share Analysis for Route 29 Corridor Study Area

	Campbell + Lynchburg, Virginia	Route 29 Corridor	Commonwealth of Virginia
1985 Employment	64,773	195,908	2,770,420
1995 Employment	74,675	230,531	3,385,301
Growth -- % Change	15.29%	17.67%	22.19%
Employment Change	9,902	34,623	614,881
Regional Growth Share	15,730	48,359	
Shift	(4,618)	(7,818)	
Industry Mix	(1,848)	(4,149)	
Differential Shift	(2,770)	(3,670)	
CONTRACT CONSTRUCTION			
1985 Employment	3,271	12,373	200,484
1995 Employment	4,329	17,246	233,759
Growth -- % Change	32.34%	39.38%	16.60%
Employment Change	1,058	4,873	33,275
Regional Growth Share	726	2,746	
Shift	332	2,127	
Industry Mix	(183)	(693)	
Differential Shift	515	2,819	
MANUFACTURING			
1985 Employment	24,174	56,372	433,568
1995 Employment	20,466	51,653	416,729
Growth -- % Change	-15.34%	-8.37%	-3.88%
Employment Change	(3,708)	(4,719)	(16,839)
Regional Growth Share	5,365	12,511	
Shift	(9,073)	(17,230)	
Industry Mix	(6,304)	(14,701)	
Differential Shift	(2,769)	(2,530)	
TRANSPORTATION			
1985 Employment	2,837	7,617	147,499
1995 Employment	3,185	8,263	176,748
Growth -- % Change	12.27%	8.48%	19.83%
Employment Change	348	646	29,249
Regional Growth Share	630	1,691	
Shift	(282)	(1,045)	
Industry Mix	(67)	(180)	
Differential Shift	(215)	(864)	
WHOLESALE TRADE			
1985 Employment	2,462	6,604	121,948
1995 Employment	3,160	8,416	151,952
Growth -- % Change	28.35%	27.44%	24.60%
Employment Change	698	1,812	30,004
Regional Growth Share	546	1,466	
Shift	152	346	
Industry Mix	59	159	
Differential Shift	92	187	
FINANCE			
1985 Employment	4,333	13,330	241,026
1995 Employment	5,237	15,390	261,666
Growth -- % Change	20.86%	15.45%	8.56%
Employment Change	904	2,060	20,640
Regional Growth Share	962	2,959	
Shift	(58)	(899)	
Industry Mix	(591)	(1,817)	
Differential Shift	533	918	
SERVICES			
1985 Employment	16,570	48,447	747,391
1995 Employment	22,444	67,549	1,134,266
Growth -- % Change	35.45%	39.43%	51.76%
Employment Change	5,874	19,102	386,875
Regional Growth Share	3,678	10,753	
Shift	2,196	8,349	
Industry Mix	4,900	14,325	
Differential Shift	(2,703)	(5,976)	

RETAIL TRADE			
1985 Employment	11,077	34,398	492,530
1995 Employment	15,721	45,635	648,742
Growth -- % Change	41.92%	32.67%	31.72%
Employment Change	4,644	11,237	156,212
Regional Growth Share	2,458	7,634	
Shift	2,186	3,603	
Industry Mix	1,055	3,275	
Differential Shift	1,131	327	
GOVERNMENT			
1985 Employment	6,149	38,748	712,084
1995 Employment	7,443	44,278	787,106
Growth -- % Change	21.04%	14.27%	10.54%
Employment Change	1,294	5,530	75,022
Regional Growth Share	1,365	8,600	
Shift	(71)	(3,070)	
Industry Mix	(717)	(4,518)	
Differential Shift	646	1,448	

Source: BEA--Wage and Salary Employment in Virginia
The SGM Group, Inc.

Date: 10-Jul-98

When coupled with the Location Quotient tables, the existing conditions evaluation identifies which major industrial sectors are relatively strong in the region. As shown in Table 4, the corridor exhibits regional strength only in the area of manufacturing. Some relative strength also exists in the construction and retail trade sectors, but other areas of the region are beginning to catch up. Relative strength in the manufacturing sector has declined slightly over time.

Table 4: Location Quotients—Route 29 Corridor

		Campbell + Lynchburg, Virginia	Route 29 Corridor
Location Quotients			
Construction			
	1985	0.70	0.87
	1994	0.84	1.08
Manufacturing			
	1985	2.38	1.84
	1994	2.23	1.82
Transportation			
	1985	0.82	0.73
	1994	0.82	0.69
Wholesale Trade			
	1985	0.86	0.77
	1994	0.94	0.81
Finance			
	1985	0.77	0.78
	1994	0.91	0.86
Services			
	1985	0.95	0.92
	1994	0.90	0.87
Retail Trade			
	1985	0.96	0.99
	1994	1.10	1.03
Government			
	1985	0.37	0.77
	1994	0.43	0.83

Source: BEA--Wage and Salary Employment in Virginia
The SGM Group, Inc.
Date: 10-Jul-98

To expand our understanding of these characteristics, we can also use US Census Bureau *County Business Patterns* which provides employment and income information at the four-digit SIC code level. Together, demographic, employment, and income information helps to create a picture of the local area economy. This picture facilitates an understanding of the potential long-term impact of possible transportation system improvements. Employment and population projections also provide an envelope for measuring future growth and development in the region that could occur without any significant changes in the status quo. Using this envelope for the no-build traffic model application indicates what local area conditions might be if expected growth occurs without changing the capacity of the system. Under this scenario, system change can only include those components already included in the existing long-range transportation improvement plan.

Application of the Traffic Model

The traffic model translates future growth and development activity into increased traffic loading on the existing and already-approved transportation system. Traffic loadings are based on average trip-generation rates calibrated to reflect existing conditions. This process integrates total employment and population change with land use by traffic analysis zones (TAZs). Local area land use and development plans are the basis for assigning locations of projected employment and household growth throughout the region. Using the existing network coupled with the baseline employment and population projections in this initial application creates a no-build condition for a target year. At that point in time, say 2020, the projected growth and development in the region will result in traffic levels which we can attribute to the no-build plus already committed alternative. Any proposed network improvement should improve the traffic level at critical congestion points by increasing system capacity. As a result, we should be able to measure these changes and compare them with those experienced in the no-build option.

To illustrate this process, we will use the output of a recently completed study that addressed similar issues—a proposed highway bypass around the City of Fredericksburg, Virginia. We will use a similar process to value economic impacts of proposed improvements under the Route 29 Corridor Study. In the Fredericksburg, Virginia, study, the process of measuring long term economic impacts began by identifying a potential linkage between the effects of proposed improvements and possible levels of employment in the impact area. For the purpose of this analysis, effects of improvements were measured by changes in highway congestion. We measured possible changes in congestion as a function of changes in vehicle hours traveled. By reducing the number of roadway lane miles subject to level of service D or worse, proposed improvements decreased the number of hours of travel under congested conditions. The traffic model measured this change in congestion in terms of vehicle hours of travel (VHT) or vehicle miles traveled (VMT).

For each proposed improvement alternative, the traffic model measures changes in VHT (or, similarly, VMT) under congested conditions against that experienced in the base case. First, we used the traffic model to measure levels of congestion for the base case highway network (existing plus committed). Then, for each of the alternatives, we used the same process to measure changes in VHT under congested conditions. The change in the number of hours of congested travel at critical locations is a measure of system improvement for that alternative.

As indicated, the traffic model uses employment and population data allocated to specific zones to generate trips. The employment and population contained in each of these zones (TAZs) is based on the population and employment projections through 2020. Allocations are based on the comprehensive plans prepared for each jurisdiction. Changes in both population and employment in the traffic analysis zones affect levels of travel throughout the network and, as a result, levels of congestion. To link possible changes in employment and levels of congestion, we used the model to test the effects of decreasing projected employment in those zones where future growth is concentrated. At the same time, using the ratio of population-to-employment measured in the existing conditions analysis, a change in number of jobs is linked directly to a change in population and number of households.

As shown in the following table, proposed transportation system improvements generated congestion savings that ranged from 0 to 8,000 VHT. In the Fredericksburg study, the regional build strategies, “Corridor/Comprehensive Plan without Bridge,” generated the lowest level of congestion savings. Both the Major Arterial and the Parkway-like Facility alternatives showed no improvement in levels of congestion. The Limited Access alternative showed an improvement of 1,000 hours. The highest level of improvement was associated the “Limited Access Regional Build Strategy along the Western Corridor with a Bridge.” This alternative generated a savings of 8,000 hours over the base case alternative. The range of effects is shown in the following table.

Table 5: Congestion Savings by Alternative

ALTERNATIVE	Congestion Savings
	(VHT)
1. No Build/Existing + Committed (00)	
2. Transit/HOV Strategy (02)	7,000
3. Local Build Strategies - Eastern Local Collector 1 with Bridge (11)	5,000
4. Local Build Strategies - Eastern Local Collector 1 without Bridge (12)	4,000
5. Local Build Strategies - Eastern Local Collector 2 without Bridge (15)	4,000
6. Regional Build Strategies - Corridor/West with Bridge	
6A. - Limited Access (30)	8,000
6B. - Major Arterial (34)	4,000
6C. - Parkway-like Facility (34)	4,000
7. Regional Build Strategies - Corridor/Comprehensive Plan with Bridge	
7A. - Limited Access (31)	4,000
7B. - Major Arterial (35)	4,000
7C. - Parkway-like Facility (35)	4,000
8. Regional Build Strategies - Corridor East with Bridge	
8A. - Limited Access (32)	5,000
8B. - Major Arterial (36)	4,000
8C. - Parkway-like Facility (36)	4,000
9. Regional Build Strategies - Corridor/Comprehensive Plan without Bridge	
9A. - Limited Access (33)	1,000
9B. - Major Arterial (37)	0
9C. - Parkway-like Facility (37)	0

Source: Post, Buckley, Schuh & Jernigan, Inc., and William G. Allen; Transportation Consultant.; The SGM Group, Inc.

To test the linkage between changes in levels of congestion and changes in employment, the model was used to vary the projected employment growth in each of the TAZs. By decreasing the projected employment growth in affected TAZs along the corridor for the base case, the procedure determined what change was necessary to equal the congestion level improvements associated with each of the proposed transportation alternatives. Using this process, the following correlation resulted:

Table 6: Employment Correlation

Estimated Change in VHT	Employment Correlation
10,000	**652**
9,000	**571**
8,000	**489**
7,000	**456**
6,000	**424**
5,000	**391**
4,000	**359**
3,000	**326**
2,000	**293**
1,000	**261**

Source: William G. Allen, Transportation Consultant; The SGM Group, Inc.

What this analysis shows is that a change in employment of just under 490 created a congestion improvement of 8,000 VHT. Similarly, an employment change of approximately 260 corresponded to a congestion improvement of 1,000 VHT. This analysis resulted in the following table, which illustrates the potential relationship between each alternative and a level of employment change that generated the same level of congestion improvement over that experienced in the base case.

Table 7: Employment Capacity by Alternative

Alternative	Congestion Savings	Employment Differential
	(VHT)	
1. No Build/Existing + Committed (00)		
2. Transit/HOV Strategy (02)	7,000	456
3. Local Build Strategies - Eastern Local Collector 1 with Bridge (11)	5,000	391
4. Local Build Strategies - Eastern Local Collector 1 without Bridge (12)	4,000	359
5. Local Build Strategies - Eastern Local Collector 2 without Bridge (15)	4,000	359
6. Regional Build Strategies - Corridor/West with Bridge		
6A. - Limited Access (30)	8,000	489
6B. - Major Arterial (34)	4,000	359
6C. - Parkway-like Facility (34)	4,000	359
7. Regional Build Strategies - Corridor/Comprehensive Plan with Bridge		
7A. - Limited Access (31)	4,000	359
7B. - Major Arterial (35)	4,000	359
7C. - Parkway-like Facility (35)	4,000	359
8. Regional Build Strategies - Corridor East with Bridge		
8A. - Limited Access (32)	5,000	391
8B. - Major Arterial (36)	4,000	359
8C. - Parkway-like Facility (36)	4,000	359
9. Regional Build Strategies - Corridor/Comprehensive Plan without Bridge		
9A. - Limited Access (33)	1,000	261
9B. - Major Arterial (37)	0	0
9C. - Parkway-like Facility (37)	0	0

Source: Post, Buckley, Schuh & Jernigan; William G. Allen, Transportation Consultant; The SGM Group, Inc.

Using this process, alternative 6A has the greatest potential employment correlation of nearly 490. The transit alternative is next with a correlation level of nearly 460. Most of the alternatives are in the range of 350 to 400. The following section examines the impact of the measured change in employment based on application of the input-output model discussed in Section I of this study. For each of the alternatives, the model is used to measure the potential annual increase in value added based on wages generated by the level of employment associated with each change in level of congestion.

Input-Output Model

As discussed in the introduction to this memorandum, using the input-output model provides a mechanism to measure the value of potential annual changes in employment. For each of the alternatives, we use the traffic model to measure possible changes in level of congestion. Associated with the measured changes in congestion are estimated changes in employment that create the same effect over the base condition as that achieved by a specific alternative. As a result, the process can measure the economic impacts of each alternative as a function of estimated corresponding changes in employment that would create the same improvement.

As indicated, the most effective alternative in the Fredericksburg study when measured in terms of changes in levels of congestion was 6A—the Limited Access version of the Regional Build Strategy along the western corridor and including a bridge across the Rappahanock River. This alternative exhibited an 8,000 VHT improvement with an equivalent employment differential of 489. Using this employment equivalent in the input-output model generated the following results:

Table 8: Value of Employment Change

Effects of Employment Change in FAMPO--2020

(Employment in jobs, not necessarily exact full-time equivalents)
(Dollar figures in Thousands)

Economic Sector	Employment	Output	Wages	Value Added
Agriculture	3.6	$1,733.1	$23.5	$913.6
Agri. Serv., Forestry, & Fish	7.0	$172.8	$56.6	$94.6
Mining	0.7	$106.4	$35.9	$61.7
Construction	56.0	$1,767.6	$1,118.0	$1,460.4
Manufacturing	28.4	$5,391.8	$1,330.7	$2,447.1
Transport. & Public Utilities	20.1	$3,803.3	$910.8	$2,498.5
Wholesale	24.1	$3,282.0	$913.9	$2,104.0
Retail Trade	113.7	$6,752.0	$2,250.3	$3,907.7
Finance, Ins., & Real Estate	49.4	$5,540.7	$1,112.2	$3,663.4
Services	137.2	$6,374.1	$2,820.0	$4,027.7
Government	48.8	$7,461.6	$1,416.0	$3,634.1
Admin. Auxiliary				
Direct Effects	327.7	$31,362.2	$8,554.1	$17,815.4
Indirect and Induced Effects	161.3	$11,023.2	$3,433.8	$6,997.3
Total Effects	489.0	$42,385.4	$11,987.8	$24,812.7
Multipliers	**1.492**	**1.351**	**1.401**	**1.393**

Wages-Net of Taxes	=	$8,347.2
State Taxes-Visitors	=	$0.0
Indirect St. Taxes	=	$978.1
Total State Taxes	=	$978.1
Local Taxes-Visitors	=	$0.0
Indirect Local Taxes	=	$1,057.1
Total Local Taxes	=	$1,057.1
Federal Taxes-Visitors	=	$0.0
General Federal Taxes	=	$2,679.8
Social Security Taxes	=	$2,034.6
Total Federal Taxes	=	$4,714.4
Other Value Added	=	$9,715.7
Total Value Added	=	$24,812.6
Direct Expenditures Within Region	=	$31,362.2
Direct Expenditures in other Regions	=	0.0
Total Initial Expenditure	=	$31,362.2

Effects per Million Dollars of Initial Expenditure		
Employment	=	15.6 Jobs
Income	=	$382,238.2
State Taxes	=	$31,187.1
Local Taxes	=	$33,706.8
Value Added	=	$791,166.8

Source: Regional Science Research Corporation and The SGM Group, Inc.

An increase in employment of 489 jobs in the FAMPO (the Fredericksburg Area Metropolitan Planning Organization) area would result in nearly $12.0 million in increased wages and value added of nearly $25.0 million. In other words, when measured in "units of employment," alternative 6A would generate an increase of nearly $25 million in value added for the region. In addition, based on local expenditures, the value of the improvement in terms of increased local tax revenues is on the order of $1.06 million annually. Similar calculations for each of the alternatives generated associated values using the correlation between changes in level of congestion and equivalent changes in level of employment.

Table 9: Impact Value by Alternative

Alternative	Total Cost	Congestion Savings	Employment Differential	Value Added	Wages	Local Taxes
	($1,000,000)	(VHT)		($1,000)	($1,000)	($1,000)
1. No Build/Existing + Committed (00)						
2. Transit/HOV Strategy (02)	**$16.20**	7,000	456	$23,138	$11,179	$986
3. Local Build Strategies - Eastern Local Collector 1 with Bridge (11)	**$59.88**	5,000	391	$19,840	$9,585	$845
4. Local Build Strategies - Eastern Local Collector 1 without Bridge (12)	**$40.08**	4,000	359	$18,216	$8,800	$776
5. Local Build Strategies - Eastern Local Collector 2 without Bridge (15)	**$48.10**	4,000	359	$18,216	$8,800	$776
6. Regional Build Strategies - Corridor/West with Bridge						
6A. - Limited Access (30)	**$144.97**	8,000	489	$24,812	$11,988	$1,057
6B. - Major Arterial (34)	**$98.17**	4,000	359	$18,216	$8,800	$776
6C. - Parkway-like Facility (34)	**$104.65**	4,000	359	$18,216	$8,800	$776
7. Regional Build Strategies - Corridor/Comprehensive Plan with Bridge						
7A. - Limited Access (31)	**$152.65**	4,000	359	$18,216	$8,800	$776
7B. - Major Arterial (35)	**$100.65**	4,000	359	$18,216	$8,800	$776
7C. - Parkway-like Facility (35)	**$107.41**	4,000	359	$18,216	$8,800	$776
8. Regional Build Strategies - Corridor East with Bridge						
8A. - Limited Access (32)	**$165.55**	5,000	391	$19,840	$9,585	$845
8B. - Major Arterial (36)	**$112.75**	4,000	359	$18,216	$8,800	$776
8C. - Parkway-like Facility (36)	**$119.63**	4,000	359	$18,216	$8,800	$776
9. Regional Build Strategies - Corridor/Comprehensive Plan without Bridge						
9A. - Limited Access (33)	**$120.45**	1,000	261	$13,243	$6,398	$564
9B. - Major Arterial (37)	**$80.45**	0	0	$0	$0	$0
9C. - Parkway-like Facility (37)	**$86.29**	0	0	$0	$0	$0

Source: Post, Buckley, Schuh & Jernigan; William G. Allen, Transportation Consultant; The SGM Group, Inc.

Therefore, alternative 9A with a 1,000 VHT improvement in congestion is equivalent to an employment benefit of 261. Total value added for this alternative would be on the order of $13.2 million based on wages of nearly $6.4 million. Local tax benefits would be on the order of $560,000 annually compared with $1.06 million for alternative 6A.

III. Measuring Fiscal Impacts

The next step in preparing the economic analysis is an estimate of the differential fiscal impacts associated with each alternative. A possible change in employment for each jurisdiction in the region has a direct impact on change in population and number of households. In turn, changes in population affect revenues and expenditures in each jurisdiction. The net change in revenues over expenditures is the fiscal impact resulting from implementation of the proposed improvement. To calculate this potential impact, the Fredericksburg analysis used existing patterns of expenditures in each of the jurisdictions to estimate 2020 per capita revenues and expenses.

Table 10: Fiscal Impact Analysis
Region: FAMPO

Fiscal Year Ending	Population	Total Revenues	Total Expenses (Excluding Transfers)	Revenue/Capita	Expenses/Capita
1990	138,836	$190,798,188	$163,625,078	$1,374.27	$1,178.55
1991	145,900	$215,591,515	$181,069,252	$1,477.67	$1,241.05
1992	153,300	$215,353,660	$188,105,641	$1,404.79	$1,227.04
1993	158,300	$252,552,742	$209,016,830	$1,595.41	$1,320.38
1994	163,600	$258,727,036	$225,826,295	$1,581.46	$1,380.36
1995	172,700	$292,066,556	$242,366,637	$1,691.18	$1,403.40
1996	178,800	$310,902,841	$263,681,927	$1,738.83	$1,474.73
1997	182,549	$330,870,701	$273,819,150	$1,812.50	$1,499.98
1998	186,298	$354,188,612	$287,892,531	$1,901.19	$1,545.33
1999	192,022	$375,216,134	$303,478,518	$1,954.03	$1,580.44
2000	197,745	$396,243,656	$319,064,505	$2,003.81	$1,613.51
2001	203,469	$417,271,178	$334,650,492	$2,050.78	$1,644.72
2002	209,193	$438,298,699	$350,236,479	$2,095.19	$1,674.23
2003	214,917	$459,326,221	$365,822,466	$2,137.23	$1,702.16
2004	220,640	$480,353,743	$381,408,453	$2,177.09	$1,728.64
2005	226,364	$501,381,265	$396,994,440	$2,214.93	$1,753.79
2006	232,088	$522,408,786	$412,580,427	$2,250.91	$1,777.69
2007	237,811	$543,436,308	$428,166,415	$2,285.16	$1,800.45
2008	243,535	$564,463,830	$443,752,402	$2,317.79	$1,822.13
2009	249,259	$585,491,352	$459,338,389	$2,348.93	$1,842.82
2010	254,982	$606,518,873	$474,924,376	$2,378.67	$1,862.58
2011	260,706	$627,546,395	$490,510,363	$2,407.10	$1,881.47
2012	266,430	$648,573,917	$506,096,350	$2,434.31	$1,899.55
2013	272,154	$669,601,438	$521,682,337	$2,460.38	$1,916.87
2014	277,877	$690,628,960	$537,268,324	$2,485.37	$1,933.47
2015	283,601	$711,656,482	$552,854,311	$2,509.36	$1,949.41
2016	289,325	$732,684,004	$568,440,299	$2,532.39	$1,964.71
2017	295,048	$753,711,525	$584,026,286	$2,554.54	$1,979.43
2018	300,772	$774,739,047	$599,612,273	$2,575.83	$1,993.58
2019	306,496	$795,766,569	$615,198,260	$2,596.34	$2,007.20
2020	312,220	$816,794,091	$630,784,247	$2,616.09	$2,020.32

Source: Auditor of Public Accounts, Commonwealth of Virginia, Comparative Report of Local Government Revenues and Expenditures, Years ending June, 1990 through 1996; The SGM Group, Inc.

Based on this analysis, for the FAMPO region it was projected that by 2020 the average per capita revenues would be just over $2,600 with annual per capita expenses of $2,020.

Changes in employment also generate changes in population and number of households. For the example showing a change of 489 jobs, it is possible to calculate potential changes in total real estate value and total estimated retail sales. This example is shown in the following table.

Table 11: Fiscal Impact—High

Real Estate Values--FAMPO

Commercial Development:	268,950	square feet
Value:	$57.10	per square foot
Total Cost:	$15,400,000	

Tax Rate--Stafford:	$1.08	per $100 Assessed Value
Tax Rate--Spotsylvania	$0.86	
Tax Rate--City of Fredericksburg	$1.16	

			%
Employment Change--Stafford:	154	employees	31.49%
Employment Change--Spotsylvania:	43		8.79%
Employment Change--Fredericksburg	292		59.71%
TOTAL:	489		100.00%

Population Increase--Stafford:	653	people
Population Increase--Spotsylvania:	175	
Population Increase--Fredericksburg:	215	
TOTAL:	1,043	

Number of Households--Stafford:	233	households
Number of Households--Spotsylvania:	58	
Number of Households--Fredericksburg:	96	
TOTAL:	387	

Estimated Housing Value:	$150,000
Housing Value--Stafford:	$34,950,000
Housing Value--Spotsylvania:	$8,700,000
Housing Value--Fredericksburg	$14,400,000
Residential Value:	$58,050,000
Commercial Value--Stafford:	$4,849,898
Commercial Value--Spotsylvania:	$1,354,192
Commercial Value--Fredericksburg	$9,195,910
Commercial Value:	$15,400,000
Real Estate Value--Stafford:	$39,799,898
Real Estate Value--Spotsylvania:	$10,054,192
Real Estate Value--Fredericksburg:	$23,595,910
Real Estate Value:	$73,450,000
Estimated Tax--Stafford:	$429,800
Estimated Tax--Spotsylvania:	$86,500
Estimated Tax--Fredericksburg:	$273,700
Total Estimated Tax:	$790,000
Increase in Retail Sales--Stafford:	$6,300,352
Increase in Retail Sales--Spotsylvania:	$1,972,530
Increase in Retail Sales--Fredericksburg:	$14,922,040
Total:	$23,194,923

Source: The SGM Group, Inc.

For comparison purposes, the lowest employment change of 261 generated the following values for real estate and retail sales.

Table 12: Fiscal Impact—Low

Real Estate Values--FAMPO

Commercial Development:	143,550	square feet	
Value:	$57.10	per square foot	
Total Cost:	$8,200,000		
Tax Rate--Stafford:	$1.08	per $100 Assessed Value	
Tax Rate--Spotsylvania	$0.86		
Tax Rate--City of Fredericksburg	$1.16		
			%
Employment Change--Stafford:	82	employees	31.49%
Employment Change--Spotsylvania:	23		8.79%
Employment Change--Fredericksburg	156		59.71%
TOTAL:	261		100.00%
Population Increase--Stafford:	349	people	
Population Increase--Spotsylvania:	93		
Population Increase--Fredericksburg:	115		
TOTAL:	557		
Number of Households--Stafford:	124	households	
Number of Households--Spotsylvania:	31		
Number of Households--Fredericksburg:	51		
TOTAL:	207		
Estimated Housing Value:	$150,000		
Housing Value--Stafford:	$18,654,000		
Housing Value--Spotsylvania:	$4,644,000		
Housing Value--Fredericksburg	$7,686,000		
Residential Value:	$30,984,000		
Commercial Value--Stafford:	$2,582,413		
Commercial Value--Spotsylvania:	$721,063		
Commercial Value--Fredericksburg	$4,896,524		
Commercial Value:	$8,200,000		
Real Estate Value--Stafford:	$21,236,413		
Real Estate Value--Spotsylvania:	$5,365,063		
Real Estate Value--Fredericksburg:	$12,582,524		
Real Estate Value:	$39,184,000		
Estimated Tax--Stafford:	$229,400		
Estimated Tax--Spotsylvania:	$46,100		
Estimated Tax--Fredericksburg:	$146,000		
Total Estimated Tax:	$421,500		
Increase in Retail Sales--Stafford:	$3,362,765		
Increase in Retail Sales--Spotsylvania:	$1,052,823		
Increase in Retail Sales--Fredericksburg:	$7,964,524		
Total:	$12,380,112		

Source: The SGM Group, Inc.

Estimated real estate taxes for the largest impact were on the order of $790,000 annually. For the lowest impact alternative, these taxes were on the order of $421,000 annually. Retail sales for the largest impact alternative were on the order of $23.2 million; for the lowest impact, $12.4 million. As a result, fiscal impact differentials for the greatest alternative could be on the order of $440,000 annually.

Table 13: Fiscal Impact Differential—High

Fiscal Impact Differential

Year 2020	**FAMPO**
Total Change in Employment	489
Population Increase-Total	1,043
Revenue/Capita	$2,616
Average Revenue Increase	$2,728,581
Expense/Capita	$2,020
Average Expense Increase	$2,107,197
Average Net Cashflow Change	$621,384
Change in State Education Payment	-$178,625
Net Cashflow Change	**$442,759**
Present Value	**$4,783,140**

For the alternative with the smallest projected impact, the fiscal differential would be on the order of $160,000 annually.

Table 14: Fiscal Impact—Low

Fiscal Impact Differential

Year 2020	**FAMPO**
Total Change in Employment	261
Population Increase-Total	557
Revenue/Capita	$2,616
Average Revenue Increase	$1,456,359
Expense/Capita	$2,020
Average Expense Increase	$1,124,700
Average Net Cashflow Change	$331,659
Change in State Education Payment	-$173,691
Net Cashflow Change	**$157,968**
Present Value	**$1,706,529**

Source: The SGM Group, Inc.

Fiscal benefits for the alternative with the greatest possible impact were approximately three times that of the alternative with the least impact. The estimated present value of the projected change in net cash flow was based on a 20-year term at rates equivalent to the 30-year Treasury bond rate. At the time of the analysis, that rate was 6.75%.

What this analysis illustrates is that even for a small change in employment, the resulting financial impacts for the region can be significant. This process links changes in employment to changes in congestion. Change in employment translates into significant change in wages for the region and, as a result, value added. In this study, overall fiscal impacts on an annual basis were reasonably small but expected to be positive, even for the alternative with the smallest measured impact. The following table summarizes the estimated fiscal impact cash flow for each of the proposed alternatives.

Table 15: Summary Fiscal Impacts

Alternative	Total Cost	Congestion Savings	Employment Differential	Value Added	Wages	Local Taxes	Annual Fiscal Impact
	($1,000,000)	(VHT)		($1,000)	($1,000)	($1,000)	($1,000)
1. No Build/Existing + Committed (00)							
2. Transit/HOV Strategy (02)	**$16.20**	7,000	456	$23,138	$11,179	$986	$402
3. Local Build Strategies - Eastern Local Collector 1 with Bridge (11)	**$59.88**	5,000	391	$19,840	$9,585	$845	$320
4. Local Build Strategies - Eastern Local Collector 1 without Bridge (12)	**$40.08**	4,000	359	$18,216	$8,800	$776	$280
5. Local Build Strategies - Eastern Local Collector 2 without Bridge (15)	**$48.10**	4,000	359	$18,216	$8,800	$776	$280
6. Regional Build Strategies - Corridor/West with Bridge							
6A. - Limited Access (30)	**$144.97**	8,000	489	$24,812	$11,988	$1,057	$442
6B. - Major Arterial (34)	**$98.17**	4,000	359	$18,216	$8,800	$776	$280
6C. - Parkway-like Facility (34)	**$104.65**	4,000	359	$18,216	$8,800	$776	$280
7. Regional Build Strategies - Corridor/Comprehensive Plan with Bridge							
7A. - Limited Access (31)	**$152.65**	4,000	359	$18,216	$8,800	$776	$280
7B. - Major Arterial (35)	**$100.65**	4,000	359	$18,216	$8,800	$776	$280
7C. - Parkway-like Facility (35)	**$107.41**	4,000	359	$18,216	$8,800	$776	$280
8. Regional Build Strategies - Corridor East with Bridge							
8A. - Limited Access (32)	**$165.55**	5,000	391	$19,840	$9,585	$845	$320
8B. - Major Arterial (36)	**$112.75**	4,000	359	$18,216	$8,800	$776	$280
8C. - Parkway-like Facility (36)	**$119.63**	4,000	359	$18,216	$8,800	$776	$280
9. Regional Build Strategies - Corridor/Comprehensive Plan without Bridge							
9A. - Limited Access (33)	**$120.45**	1,000	261	$13,243	$6,398	$564	$158
9B. - Major Arterial (37)	**$80.45**	0	0	$0	$0	$0	$0
9C. - Parkway-like Facility (37)	**$86.29**	0	0	$0	$0	$0	$0

Source: Post, Buckley, Schuh & Jernigan; William G. Allen, Transportation Consultant; The SGM Group, Inc.

The most significant issue with respect to using the fiscal impact analysis component to cap off the economic valuation for the corridor is the proliferation of independent jurisdictions. The number of such units makes it difficult to approach the problem in a comprehensive fashion. A potential solution is the selection of a set of specific examples designed to be representative of those types of situations faced by the study area as a whole. Using that approach could provide a reasonable characterization of the opportunities and constraints that would face the local area jurisdictions as they move to implement whatever final plan is approved.

IV. Economic Impacts of Construction Expenditures

Economic impacts of regional employment growth are annual effects. Impacts resulting from construction expenditures occur only during the period of construction. This next section describes the method used to evaluate the variation in construction impacts among the alternatives based on estimated construction cost. For the purposes of this analysis, costs are divided into four categories: engineering costs, right-of-way costs, roadway construction, and bridge construction. Right-of-way costs are excluded from the calculation, because they involve a transfer of capital rather than capital creation through purchases and employment. The other three categories have different average wages and multipliers and are therefore considered separately.

Cost Summary

The basis for estimating the economic impacts of construction expenditures is the potential cost which varies by alternative. As shown in the following table, the cost of construction for alternatives considered in the Fredericksburg study varied from a low of $16.2 million for local components of the Transit/HOV alternative, to $165.55 million for the Limited Access Regional Build Strategy along the Eastern Corridor with a Bridge. As this earlier study evolved, it turned out that the Transit Alternative considered only *local* components and, therefore, excluded most of associated construction costs. Among the other alternatives, major differences were attributed to inclusion of a bridge in the design and the number of interchanges for limited-access improvements. The differential cost of a limited-access versus major arterial or parkway alternative along the same corridor was on the order of $40 to $50 million. The additional cost of including a bridge across the Rappahanock River was approximately $45 million.

The value of economic impacts of construction will vary as a function of total cost as well as type of construction. It also varies as a function of the ability of the region to capture a fair share of the construction contracts. The capture potential is measured as part of the input-output model, which reflects the existence of local area contractors and their ability to absorb the demand for work. Total impacts are also measured during the period of construction. For the purposes of this analysis and to compare alternatives, it was assumed that all construction would occur in one year. Multi-year contracts would require dividing total impacts by the number of years to determine what benefit would occur during that year.

Table 16: Construction Impacts

Alternative	Roadway Construction Costs	Engineering Costs	Bridge Costs	Right of Way	Total Cost
					($1,000,000)
1. No Build/Existing + Committed (00)					
2. Transit/HOV Strategy (02)	16.20				**$16.20**
3. Local Build Strategies - Eastern Local Collector 1 with Bridge (11)	31.60	6.32	10.10	11.86	**$59.88**
4. Local Build Strategies - Eastern Local Collector 1 without Bridge (12)	24.91	4.98	0.00	10.18	**$40.08**
5. Local Build Strategies - Eastern Local Collector 2 without Bridge (15)	26.27	5.25	4.20	12.38	**$48.10**
6. Regional Build Strategies - Corridor/West with Bridge					
6A. - Limited Access (30)	85.63	7.53	41.42	10.40	**$144.97**
6B. - Major Arterial (34)	43.63	7.53	36.62	10.40	**$98.17**
6C. - Parkway-like Facility (34)	45.56	7.91	36.62	14.56	**$104.65**
7. Regional Build Strategies - Corridor/Comprehensive Plan with Bridge					
7A. - Limited Access (31)	91.54	7.51	42.47	11.13	**$152.65**
7B. - Major Arterial (35)	43.54	7.51	38.47	11.13	**$100.65**
7C. - Parkway-like Facility (35)	45.47	7.89	38.47	15.58	**$107.41**
8. Regional Build Strategies - Corridor East with Bridge					
8A. - Limited Access (32)	94.02	8.00	52.51	11.02	**$165.55**
8B. - Major Arterial (36)	46.02	8.00	47.71	11.02	**$112.75**
8C. - Parkway-like Facility (36)	48.07	8.41	47.71	15.43	**$119.63**
9. Regional Build Strategies - Corridor/Comprehensive Plan without Bridge					
9A. - Limited Access (33)	74.48	6.50	29.87	9.60	**$120.45**
9B. - Major Arterial (37)	38.48	6.50	25.87	9.60	**$80.45**
9C. - Parkway-like Facility (37)	40.15	6.83	25.87	13.44	**$86.29**

Source: Post, Buckley, Schuh & Jernigan.

We divided total cost for each alternative into four categories. As indicated, right-of-way costs are a transfer of capital and do not generate multiplier effects. Engineering, bridge, and roadway construction experience different wage and skill levels, leading to different multiplier effects. Therefore, separate input-output tables were calculated for each category.

Table 17 shows an application for each $1.0 million expenditure in roadway construction costs. In the Fredericksburg, Virginia, region, highway construction generated just over 20 jobs per $1.0 million in expenditure. Wages exceeded $540,000 per million and value added was just over $704,000 per million in highway construction cost.

Table 17: Construction Impacts—Highway Component
(Per $1.0 Million in costs)
(Employment in jobs, not necessarily exact full-time equivalents)
(Dollar figures in Thousands)

Economic Sector	Employment	Output	Wages	Value Added
Agriculture	0.0	0.3	0.0	0.2
Agri. Serv., Forestry, & Fish	0.4	8.6	4.8	6.2
Mining	0.1	7.7	2.5	4.6
Construction	13.4	495.2	369.7	406.2
Manufacturing	1.3	221.1	63.2	80.8
Transport. & Public Utilities	0.4	49.7	14.9	32.3
Wholesale	0.4	59.2	15.1	37.5
Retail Trade	1.4	58.9	19.9	32.8
Finance, Ins., & Real Estate	0.7	81.4	18.9	51.4
Services	1.9	80.0	32.3	48.4
Government	0.2	7.7	2.8	4.2
Admin. Auxiliary	0.0	0.0	0.0	0.0
Direct Effects	15.1	$750.2	$442.1	$512.3
Indirect and Induced Effects	5.1	$319.6	$102.0	$192.3
Total Effects	20.2	$1,069.8	$544.1	$704.6
Multipliers	**1.338**	**1.426**	**1.231**	**1.375**

Wages-Net of Taxes	=	$419.0
State Taxes-Visitors	=	$0.0
Indirect St. Taxes	=	$40.0
Total State Taxes	=	$40.0
Local Taxes-Visitors	=	$0.0
Indirect Local Taxes	=	$42.9
Total Local Taxes	=	$42.9
Federal Taxes-Visitors	=	$0.0
General Federal Taxes	=	$76.1
Social Security Taxes	=	$57.8
Total Federal Taxes	=	$133.9
Other Value Added	=	$68.8
Total Value Added	=	$704.6
Direct Expenditures Within Region	=	$750.2
Direct Expenditures in other Regions	=	249.8
Total Initial Expenditure	=	$1,000.0

Effects per Million Dollars of Initial Expenditure		
Employment	=	20.2 Jobs
Income	=	$544,100.0
State Taxes	=	$40,000.0
Local Taxes	=	$42,900.0
Value Added	=	$704,600.0

Table 18 illustrates the impacts per $1.0 million of Engineering expenditures. Engineering expenditures generated 18.5 jobs per $1.0 million on wages of $600,000 per million. Value added exceeded $760,000 per million.

Table 18: Construction Impacts—Engineering Component
(Per $1.0 Million in costs)
(Employment in jobs, not necessarily exact full-time equivalents)
(Dollar figures in Thousands)

Economic Sector	Employment	Output	Wages	Value Added
Agriculture	0.0	0.2	0.0	0.1
Agri. Serv., Forestry, & Fish	0.0	0.5	0.2	0.3
Mining	0.0	0.0	0.0	0.0
Construction	0.3	8.1	5.0	6.7
Manufacturing	0.2	20.5	6.1	8.7
Transport. & Public Utilities	0.1	40.7	11.6	27.6
Wholesale	0.2	18.9	5.6	12.0
Retail Trade	1.9	83.3	28.2	46.3
Finance, Ins., & Real Estate	1.0	107.5	21.8	70.9
Services	14.6	990.7	523.7	583.0
Government	0.2	8.7	3.8	5.1
Admin. Auxiliary	0.0	0.0	0.0	0.0
Direct Effects	10.6	$789.3	$435.2	$460.3
Indirect and Induced Effects	7.9	$489.8	$170.8	$300.4
Total Effects	18.5	$1,279.1	$606.0	$760.7
Multipliers	**1.745**	**1.621**	**1.392**	**1.653**

Wages-Net of Taxes	=	$468.7
State Taxes-Visitors	=	$0.0
Indirect St. Taxes	=	$43.8
Total State Taxes	=	$43.8
Local Taxes-Visitors	=	$0.0
Indirect Local Taxes	=	$47.1
Total Local Taxes	=	$47.1
Federal Taxes-Visitors	=	$0.0
General Federal Taxes	=	$82.1
Social Security Taxes	=	$62.4
Total Federal Taxes	=	$144.5
Other Value Added	=	$56.5
Total Value Added	=	$760.6
Direct Expenditures Within Region	=	$789.3
Direct Expenditures in other Regions	=	210.7
Total Initial Expenditure	=	$1,000.0

Effects per Million Dollars of Initial Expenditure			
Employment	=	18.5	Jobs
Income	=	$606,000.0	
State Taxes	=	$43,800.0	
Local Taxes	=	$47,100.0	
Value Added	=	$760,700.0	

Table 19 illustrates the impacts per $1.0 million of expenditures on bridge construction. Bridge construction, with the highest concentration of skills, generated nearly 25 jobs per million in expenditures on wages of $544,000 per million. Value added exceeded $752,000 per million.

Table 19: Construction Impacts—Bridge Component
(Per $1.0 Million in costs)
(Employment in jobs, not necessarily exact full-time equivalents)
(Dollar figures in Thousands)

Economic Sector	Employment	Output	Wages	Value Added
Agriculture	0.0	0.2	0.0	0.1
Agri. Serv., Forestry, & Fish	0.0	1.8	0.4	1.0
Mining	0.0	3.8	1.2	2.3
Construction	18.5	578.6	394.2	481.8
Manufacturing	1.1	161.8	44.1	58.4
Transport. & Public Utilities	0.4	45.9	13.5	29.9
Wholesale	0.5	63.2	16.2	40.0
Retail Trade	1.5	64.4	21.6	35.8
Finance, Ins., & Real Estate	0.7	82.5	19.1	52.1
Services	1.9	77.0	31.0	46.6
Government	0.2	7.5	2.7	4.1
Admin. Auxiliary	0.0	0.0	0.0	0.0
Direct Effects	19.6	$759.6	$442.1	$557.4
Indirect and Induced Effects	5.2	$327.1	$101.9	$194.7
Total Effects	24.8	$1,086.7	$544.0	$752.1
Multipliers	**1.265**	**1.431**	**1.230**	**1.349**

Wages-Net of Taxes	=	$414.4
State Taxes-Visitors	=	$0.0
Indirect St. Taxes	=	$40.7
Total State Taxes	=	$40.7
Local Taxes-Visitors	=	$0.0
Indirect Local Taxes	=	$43.8
Total Local Taxes	=	$43.8
Federal Taxes-Visitors	=	$0.0
General Federal Taxes	=	$81.2
Social Security Taxes	=	$61.7
Total Federal Taxes	=	$142.9
Other Value Added	=	$110.4
Total Value Added	=	$752.2
Direct Expenditures Within Region	=	$759.6
Direct Expenditures in other Regions	=	240.4
Total Initial Expenditure	=	$1,000.0

Effects per Million Dollars of Initial Expenditure		
Employment	=	24.8 Jobs
Income	=	$544,000.0
State Taxes	=	$40,700.0
Local Taxes	=	$43,800.0
Value Added	=	$752,100.0

The next section demonstrates the steps required to determine total economic value for each alternative based on separate categories of cost and total estimated construction value.

Economic Impact

A summary of construction-related economic impacts for the Fredericksburg Bypass study is shown in the following table. Job generation rates ranged from 327 for the local-share component of the transit/HOV alternative to 3,350 for alternative 8A, the limited access regional build strategy along the eastern corridor that included a bridge across the Rappahanock River. As the most expensive alternative, 8A also generated the highest level

of value added for the region at nearly $112 million during the period of construction. If the period of construction had been scheduled for five years, for example, the average number of jobs per year would be have been 670, and the average annual value added would have been $22.4 million

Table 20: Construction Impacts by Alternative

Alternative	Total Cost	Construction Impact-Employment	Construction Impact-Value Added
	($1,000,000)		($1,000)
1. No Build/Existing + Committed (00)			
2. Transit/HOV Strategy (02)	**$16.20**	327	$11,414
3. Local Build Strategies - Eastern Local Collector 1 with Bridge (11)	**$59.88**	1,005	$34,668
4. Local Build Strategies - Eastern Local Collector 1 without Bridge (12)	**$40.08**	595	$21,344
5. Local Build Strategies - Eastern Local Collector 2 without Bridge (15)	**$48.10**	732	$25,662
6. Regional Build Strategies - Corridor/West with Bridge			
6A. - Limited Access (30)	**$144.97**	2,896	$97,208
6B. - Major Arterial (34)	**$98.17**	1,929	$64,004
6C. - Parkway-like Facility (34)	**$104.65**	1,975	$65,662
7. Regional Build Strategies - Corridor/Comprehensive Plan with Bridge			
7A. - Limited Access (31)	**$152.65**	3,041	$102,151
7B. - Major Arterial (35)	**$100.65**	1,972	$65,322
7C. - Parkway-like Facility (35)	**$107.41**	2,018	$66,974
8. Regional Build Strategies - Corridor East with Bridge			
8A. - Limited Access (32)	**$165.55**	3,350	$111,827
8B. - Major Arterial (36)	**$112.75**	2,261	$74,396
8C. - Parkway-like Facility (36)	**$119.63**	2,310	$76,157
9. Regional Build Strategies - Corridor/Comprehensive Plan without Bridge			
9A. - Limited Access (33)	**$120.45**	2,365	$79,885
9B. - Major Arterial (37)	**$80.45**	1,539	$51,511
9C. - Parkway-like Facility (37)	**$86.29**	1,579	$52,942

The most expensive alternative and, as a result, the alternative generating the highest level of economic benefit from construction dollars spent was alternative 8A. As shown in the following table, this alternative would have created 3,350 jobs during construction and nearly $112 million in value added for the region from contract expenditures and related wages and salaries. It would also have generated over $6.7 million in local taxes and over $6.2 million in state taxes. Direct expenditures within the region were estimated at nearly $117 million with an additional $38 million that would have been spent outside the region. Other alternatives generated proportional effects based on differences in total estimated construction costs.

Table 21: Total Construction Impacts

Alternative: 8A. - Limited Access (32)

(Employment in jobs, not necessarily exact full-time equivalents)
(Dollar figures in Thousands)

	Total Cost ($1.0 million) $154.53			
	Employment	**Output**	**Wages**	**Value Added**
Direct Effects	2,533.7	$116,737.0	$68,263.7	$81,119.2
Indirect and Induced Effects	815.8	$51,144.8	$16,307.8	$30,707.9
Total Effects	3,349.5	$167,881.8	$84,571.5	$111,827.0
Multipliers	**1.322**	**1.438**	**1.239**	**1.379**

Wages-Net of Taxes	$64,905.5
State Taxes-Visitors	$0.0
Indirect St. Taxes	$6,248.5
Total State Taxes	$6,248.5
Local Taxes-Visitors	$0.0
Indirect Local Taxes	$6,710.3
Total Local Taxes	$6,710.3
Federal Taxes-Visitors	$0.0
General Federal Taxes	$12,075.8
Social Security Taxes	$9,173.6
Total Federal Taxes	$21,249.4
Other Value Added	$12,717.8
Total Value Added	$111,831.5
Direct Expenditures Within Region	$116,737.0
Direct Expenditures in other Regions	$37,795.8
Total Initial Expenditure	$154,532.8

Effects per Million Dollars of Initial Expenditure	
Employment =	21.7 Jobs
Income =	$547,272.0
State Taxes =	$40,434.7
Local Taxes =	$43,423.4
Value Added =	$723,646.0

For the most expensive alternative, during the period of construction, job creation was estimated at nearly 3,400 with wages on the order of $85 million based on a total construction investment of nearly $155 million. As a result, the expenditure of funds for proposed transportation improvements in the region would have generated significant economic benefits, of which a large portion would have been captured within the region. Construction impacts for each of the alternatives are shown in table 22 in the “Conclusions” section.

V. Conclusions

As presented, the economic impact analysis methodology measures value for both long- and short-term (construction) effects of possible investment in alternative transportation improvements for the Route 29 Corridor Study. Long-term effects addressed by this process include potential changes in employment that represent the same decrease in the level of congestion as that projected for each of the proposed improvements. We measure this change against a similar measurement for the base line alternative. These effects consider change in employment, total wages represented by that possible employment differential, value added to the regional economy, and potential fiscal impacts based on local tax revenues and costs.

The Fredericksburg Bypass study is an example of how to carry out this process. It shows that, even for relatively small employment change equivalents, long-term effects can be significant. In this study, resulting differential levels of congestion ranged from zero to approximately 8,000 vehicle hours of travel. For that region, this congestion-effect was equivalent to an employment differential within the surrounding region on the order of 500 jobs for the most successful alternative.

Potential changes in level of employment are not meant to represent a real loss in employment if no improvements are made. It is impossible to define such a direct effect, but experience does indicate that lack of accessibility within a highly competitive region can inhibit growth. What this methodology does represent is a process for equating changes in employment with potential improvement in levels of congestion—a significant objective of proposed system improvement alternatives. By using the traffic model and its reliance on changes in population and employment to generate trips, we can create a direct correlation between employment change and change in congestion as a function of change in system capacity. This methodology then uses that correlation to estimate an economic value for each of the proposed transportation system improvements.

The method for measuring the value of changes in employment is based on application of multipliers that result from use of input-output models. These models calculate the resulting changes in regional production as a function of changes in employment and demand for new product and services. Wages associated with employment translate to household spending which, in turn, generate additional employment. This spending and re-spending of income as captured within the region creates value. What is important is that this value continues to grow as the region continues to grow and develop. That continued growth is the basis for estimated long-term effects.

Short-term impacts are the result of one-time spending during construction of the proposed improvements. Based on ability to capture its share of expenditures through construction contracts and through production of materials used in construction, the region benefits through spending and re-spending of income produced. Again, the measure of this cyclical economic effect is determined through the use of input-output tables which reflect the ability of the region to benefit economically from the investment. Different components of development experience different measures of benefits. Engineering activities accentuate the design and development of plans and proposals. Construction of highways and interchanges uses a particular distribution of labor and skills. Bridge construction uses a slightly different set of skills as well as different materials. For each of these categories we have used input-output models to measure the multiplier effects of the proposed investments and to determine total value. This value, measured in terms of new jobs, total wages, value added to the economy, and increase in local taxes, represents the short-term economic impact of the proposed investment strategy.

The following table illustrates the summary of impacts measured, both long-term as well as short-term, in the Fredericksburg Study. For the long-term, maximum job creation is based on an increase of nearly 490 jobs for alternative 6A, the limited access western corridor regional build strategy with a bridge across the Rappahannock River. When completed, this alternative would generate approximately $25 million in value added for the region with increased wages on the order of $12 million. Local taxes realized would be on the order of $1 million with fiscal benefits averaging near $450,000 annually. During construction, this same alternative would create a demand for nearly 2,900 employees over the life of the project with value added approaching $100 million. Total cost of construction is nearly $145 million.

Table 22: Impact Analysis Summary

Alternative	Total Cost	Congestion Savings	Employment Differential	Value Added	Wages	Local Taxes	Fiscal Impact-Net Change in Cashflow	Construction Impact-Employment	Construction Impact-Value Added
	($1,000,000)	(VHT)		($1,000)	($1,000)	($1,000)			($1,000)
1									
2	**$16.20**	7,000	456	$23,138	$11,179	$986	$401,767	327	$11,414
3	**$59.88**	5,000	391	$19,840	$9,585	$845	$320,364	1,005	$34,668
4	**$40.08**	4,000	359	$18,216	$8,800	$776	$280,349	595	$21,344
2	**$48.10**	4,000	359	$18,216	$8,800	$776	$280,349	732	$25,662
6									
6A	**$144.97**	8,000	489	$24,812	$11,988	$1,057	$442,759	2,896	$97,208
6B	**$98.17**	4,000	359	$18,216	$8,800	$776	$280,349	1,929	$64,004
6C	**$104.65**	4,000	359	$18,216	$8,800	$776	$280,349	1,975	$65,662
7									
7A	**$152.65**	4,000	359	$18,216	$8,800	$776	$280,349	3,041	$102,151
7B	**$100.65**	4,000	359	$18,216	$8,800	$776	$280,349	1,972	$65,322
7C	**$107.41**	4,000	359	$18,216	$8,800	$776	$280,349	2,018	$66,974
8									
8A	**$165.55**	5,000	391	$19,840	$9,585	$845	$320,364	3,350	$111,827
8B	**$112.75**	4,000	359	$18,216	$8,800	$776	$280,349	2,261	$74,396
8C	**$119.63**	4,000	359	$18,216	$8,800	$776	$280,349	2,310	$76,157
9									
9A	**$120.45**	1,000	261	$13,243	$6,398	$564	$157,968	2,365	$79,885
9B	**$80.45**	0	0	$0	$0	$0	$0	1,539	$51,511
9C	**$86.29**	0	0	$0	$0	$0	$0	1,579	$52,942

The most expensive alternative, 8A (limited access eastern corridor with a bridge across the Rappahannock), would create a demand for over 3,300 employees during the construction period, with wages exceeding $84.5 million and value added of approximately $112 million. The estimated total cost of this alternative is $165 million, including approximately $11 million in right-of-way acquisition. Construction investment, therefore, would reach approximately $154 million.

This analysis demonstrates that the proposed improvements would create significant value for the Fredericksburg region. At the same time, the estimate of potential fiscal benefits indicates that changes in net cash flow for the region are not sufficient to underwrite a substantial portion of the cost of construction. For the best alternative, net change in cash flow is nearly $450,000 annually. Over a twenty-year term at 6.75% interest, this cash flow has a net present value of approximately $4.8 million.

As a comprehensive systematic approach, this methodology offers an opportunity to evaluate economic effects of proposed transportation system alternatives. It covers long-term effects by looking at the value of proposed improvements in terms of employment and resulting trip capacity of the final system. It also examines fiscal impacts on local communities to the extent possible by measuring the differences between projected revenues and costs. Finally, it examines short-term economic impacts by measuring the effects of construction activity. The basis for measurement and comparison in all components is units of employment. Once we can measure the potential change in system capacity and, therefore, its ability to absorb new employment, then we can use that change to measure relative value.

Appendix

Appendix A: Input-Output Modeling

As presented in this study, the method used to value potential economic effects of proposed transportation system improvements is an application of regional input-output models. These models measure the result of direct, indirect, and induced spending on the economy. They build on existing conditions and linkage characteristics to predict the potential capture within a defined region of a direct infusion of capital.

To illustrate the principles involved, consider the example of increasing activity in the wholesale and retail trade sectors—two key economic sectors that could expand in the corridor study area as a function of improved transportation system capacity. Both of these sectors are important to the region. For the wholesale trade sector, multipliers are generally small, primarily because of the lack of diverse intermediate products. For retail trade, however, increasing development generates greater demand for suppliers as well as some local demand for increased manufacture, depending on the capabilities of the region. In turn, these increased demands require inputs before they can supply the retail sector. These requirements of inputs are known as intermediate demands, in contrast to final demands, which are the requirements for consumption by individuals or households. In input-output analysis, the pattern of intermediate demands is the prime consideration. By examining the relationship between intermediate demand, industrial output, and final demand, it is possible to predict the effects of a forecast change in the output of one industry on the rest of the economy, and also the effects on each industry of a change in national output. Understanding and predicting these relationships is essential to forecasting the impact of changes in the ability to support additional manufacturing.[2]

Other components of spending include household spending resulting from wages received by workers at expanded employment facilities in the study region. Wages received by employees are spent on housing, food, clothing, and other required living expenses; and, subsequently, these expenditures serve as income to those providing the services to households. Expenditures continue to multiply as long as they are captured within the region. These subsequent rounds of expenditures to acquire additional goods and services are defined as induced impacts generated by the initial direct expenditure. The value of those goods and services produced that are required as direct inputs to construction and industrial facilities, that would locate within the region as a result of expanded capacity of the transportation network, represent the indirect impacts resulting from the initial improvement expenditure.

The combination of indirect and induced effects have a "ripple-like" quality, passing from one layer of the economy to the next. The ripple effect is reduced, however, when the goods and services purchased, or labor resources employed, originate outside the specific jurisdiction under study. It is necessary to estimate this leakage function in evaluating the total impact of the successive rounds of spending in the economy, and this estimate is generated by examining the capacity of the local economy to provide the product and labor resources required for construction and manufacturing. The indirect and induced effects of the initial direct expenditures of a public project are defined, respectively, as follows:

- Indirect: The local jobs, materials, equipment, and services required to produce the non-labor resources; and

- Induced: The local jobs, materials, equipment, and services required to fulfill the household demands for goods and services, which are generated by the wages of additional employees.

[2] Economic Forecasting: An Introduction, by K. Holden, D.A. Peel, and J.L. Thompson, Cambridge University Press, 1994, pp. 25-27.

The ripple impact of the indirect and induced effects multiplies the original impact of the purchase, represented by the cost of new construction of the transportation system improvements and the projected scale of associated industrial activity. The common measure of the magnitude of the ripple effect is called a multiplier. A multiplier measures the total magnitude of the impact on each particular economic indicator as a multiple of the initial, direct effect. For instance, a multiplier of 1.0 would signify no ripple effect as the total impact was only 1.0 times the initial impact. In contrast, a multiplier of 2.0 would imply that the total impact of the proposed investment is twice the direct effect.

The actual magnitude of a multiplier depends on the likelihood that goods and services purchased in a region would be produced in, or provided from, that region. A common technique used in the performance of an economic impact study is to determine the total direct "economic impact" (by which most studies mean the impact on one economic indicator: the total output) of the project and then multiply that amount by an assumed multiplier. Such a method is inherently inaccurate, since the actual multiplier depends on the nature of the purchases, the types of materials with which the goods are produced, and the particular purchase patterns of the geographic region being measured.

In previous studies, including Fredericksburg Bypass, we have applied a sophisticated input-output model developed by Regional Science Research Corporation (RSRC) to avoid inherent inaccuracy of assumed multipliers. We have used this model to estimate the total economic impact of proposed development alternatives.[3] This model does not assume a multiplier but, rather, uses past consumption and production patterns in the surrounding region to estimate what portion of the purchased goods and services actually originate or are produced in the region. The resulting multiplier is the total impact which the model estimates, per indicator measured, divided by the amount of the original direct impact on the indicator. The model results are used as examples in the applications discussion in part II of this paper.

The calculation of indirect and induced effects requires an input-output technology coefficients matrix, otherwise known as the direct coefficients matrix. Elements in this matrix express the dollar's worth of each resource required per dollar's worth of production. Generally, the data in such a matrix are based on data collected by region-specific surveys, or by "regionalizing" a national technology coefficients matrix. The latter are produced by several sources, most notably, the Bureau of Labor Statistics (BLS) of the US Department of Labor and the Bureau of Economic Analysis (BEA) of the US Department of Commerce.

The technological coefficients allow for the determination of changes in demand for resources by a sector associated with a change in employment or production in that sector. In regional analysis, these demands will, in general, only be partially fulfilled by other sectors in the same region. All or part of the purchases of many goods and some services will leak out of the region and result in payments for goods and services imported from other regions. These leakages reduce the indirect and induced effects on the economy of the region where the direct changes occur and consequently reduce the multiplier effects of that change.

RSRC built the input-output models used in this analysis through methods applied over a period of years. These methods are designed to allow the estimation of the necessary region-specific data for any region beginning at the county level. Although other approaches exist in theory, the most pragmatic approach to regionalizing a US national I-O technological coefficients matrix is that based on estimating the degree to which a region provides its own inputs. In the economic impact models used to produce the results in the body of this analysis, regional purchase coefficients (RPCs) are estimated at the four-digit Standard Industrial Classification (SIC) level via regression analysis. An RPC for a specific good or

[3] A Regional Impact Model for the Personal Computer, 1986-1996, by Regional Science Research Corporation, Hightstown, New Jersey.

service is defined as the proportion of the demand for that good or service that is fulfilled by that region, rather than being imported from other regions.

The regression equation is estimated using data on state imports and exports for each of the 50 states for four-digit SIC equivalent commodities available in the Census of Transportation. The underlying theory that dictated the form of the RPC equation is that the variation in the size of the RPCs for a given good among regions can be explained by the delivered cost of the good produced by the region relative to the delivered cost to the region when produced elsewhere. The variables used in the equation include relative wage costs of the industry in the region compared to that of the nation, land area, weight-to-value ratio of the commodity, and the supply/demand ratio for the commodity in the region.

In regionalizing the model with RPCs, it is assumed that technology is the same everywhere in the US, and that differences in the use of goods across regions is strictly dependent on differences in production in corresponding sectors. Therefore, it is the set of RPCs that is unique to a region and not the technological relationships themselves. This greatly reduces the data needs of such a model, making it both affordable and accurate.

The model uses information updated regularly for the fifty states to reflect recent employment and wage data published by the federal government. These data are estimated at the four-digit SIC level, aggregated to the two-digit SIC level where they are reconciled with published data and re-allocated to the four-digit level so that an accurate, detailed analysis of a regional economy can be performed. These data are then used in a pre-specified regression equation with other non-updated data to obtain a set of RPCs specific to the region being modeled. The basic employment and wage data for this study are based on the latest available County Business Patterns (1996). The CBP data, which are available at the 4-digit SIC level, are regularly adjusted at the state level to sum to the Regional Economic Information Service (REIS) data. The latter provide more complete and accurate coverage, albeit at a higher level of aggregation, the 2-digit SIC. The better coverage in REIS, which includes railroad, government enterprises, and other sectors not available in the CBP, comes from the use of Covered Employment and Wages, or ES-202, data. These data are collected regularly, year-round, rather than being based on a survey in the single month of March, as is CBP. The REIS data at the state level include wages, earnings, and employment, subject to disclosure problems.

Two other region-specific components of the modeling system are labor requirements and household expenditures by industry. The labor requirements are specified in terms of wages, salaries, and proprietor's incomes paid to labor and proprietors per dollar of production by each sector. Household expenditures on the goods and services of a specific industry are expressed in dollars per dollar of income. In this manner, households can be treated like any other industry with the labor requirements representing its "sales" of labor services, and household expenditures representing the resources it requires to produce the labor demanded. The main difference between this sector and the others is that all of the coefficients for this sector are tailored specifically to the region being modeled using such sources as the Consumer Expenditure Survey, Census of Wholesale Trade, Census of Retail Trade, Census of Manufactures, Annual Survey of Manufactures, County Business Patterns, Earnings and Employment Estimates, and recent data from local sources.

Other data elements do not modify the impacts calculated by the model. Instead they are applied after the economic impacts by sector are determined. These elements are region-specific state and local taxes and "other" value added. "Other" value added consists primarily of federal taxes and returns to capital. As such, these payments are assumed to leak out of the region.