Economic Benefits of Toll Roads
Operated by the Transportation Corridor Agencies

Prepared by
LeCG
Emeryville, California

June 2006
Economic Benefits of Toll Roads
Operated by the Transportation Corridor Agencies

Prepared by
Tapan Munroe, Ph.D., Director
Ronald Schmidt, Ph.D., Principal
Mark Westwind, MPA, Senior Consultant

June 2006
Table of Contents

Introduction ............................................................................................... 1
   A. Brief History of Toll Roads ................................................................. 1
   B. A Study of TCA Toll Roads ................................................................. 2
   C. Key Findings ....................................................................................... 2

I. Economic Concepts............................................................................... 3
   A. The Economics of Toll Roads ............................................................. 3
   B. Advantages of Road Pricing................................................................. 6

II. Overview of TCA Toll Roads............................................................... 7
   A. History of TCA Toll Roads .................................................................. 7
   B. Overview of the TCA Toll Road System ............................................. 8
   C. Usage of TCA Toll Roads ................................................................... 9
   D. Toll Structure ..................................................................................... 11
   E. Toll Road Revenues .......................................................................... 12

III. Economic Benefits of TCA’s Toll Roads ........................................... 13
   A. Impacts of Traffic Congestion ........................................................... 13
   B. Toll Roads Reduce Traffic Congestion ............................................. 13
   C. Economic Benefits of Congestion Reduction .................................... 17
   D. Improved Fuel Efficiency................................................................... 19
   E. Other Economic Benefits .................................................................. 21

IV. Conclusions ....................................................................................... 22

Appendix .................................................................................................. 23
   Methodology of Traffic Monitoring and Congestion Measurement........ 23
   CalTrans Traffic Data ............................................................................ 25

Authors..................................................................................................... 26
   Tapan Munroe, PhD .............................................................................. 26
   Ronald Schmidt, PhD ............................................................................ 26
   Mark Westwind, MPA ............................................................................ 27

LECG, LLC, a global expert services firm, one of the few consulting firms listed in NASDAQ, provides independent expert testimony, original authoritative studies, and strategic advisory services to clients including Fortune Global 500 corporations, major law firms, community banks, and local, state, and federal governments and agencies around the world. LECG’s highly credentialed experts and professional staff conduct economic and financial analyses to provide objective opinions and advice that help resolve complex disputes and inform legislative, judicial, regulatory, and business decision makers. In addition to its world headquarters in Emeryville, California, the company has offices in San Francisco, Palo Alto, Los Angeles, Atlanta, Chicago, Cambridge (Mass.) Dallas, Evanston, Houston, Nashville, New York, Philadelphia, Salt Lake City, Washington D.C., Toronto, Brussels, London, Madrid, Paris, Auckland (NZ), Wellington (NZ), Seoul, Sydney, and Buenos Aires.

Note: The opinions and conclusions expressed in this report are solely that of the authors.
Introduction

A. Brief History of Toll Roads

Toll roads are an ancient concept. Aristotle in his writings mention use of tolls in many parts of Asia including India where tolls were levied as far back as the 4th century BC, tolls were used in the 14th and 15th centuries in the Holy Roman empire.

The first major toll road in the U.S, the Lancaster Turnpike, between Philadelphia and Lancaster, was built in the 1790s. The Great Western Turnpike between Albany and the Finger Lakes, in New York State, was started in 1799. California and Nevada were fairly early entrants in the building of toll roads. In the mid to late 19th century the state of Nevada had more than 100 privately owned toll roads and some of them were nearly 200 miles long.

With the arrival of the 20th century, most toll roads in the U.S. were taken over by state highway departments, or quasi-governmental authorities. Toll revenue bonds were issued for funding the construction and maintenance. The Pennsylvania Turnpike, which opened in 1940, started the resurgence in toll collection for funding and maintaining limited access multi-lane highways. In the aftermath of World War II, many major toll-highways were built, mostly in the Eastern and Midwestern states. The list includes the New York State Thruway, Illinois Toll Highway, Indiana Toll Road, Massachusetts Turnpike, Ohio Turnpike, Connecticut Turnpike (tolls were eliminated in 1985), New Jersey Turnpike, and several Oklahoma turnpikes.

While most major highways and bridges in Western Europe and Japan are financed by tolls and despite the growing worldwide trend in the development of toll roads, surprisingly very few toll roads are in existence in the western U.S. today - toll roads are a rarity in California, one of the top ten economies in the world.

Most roads in the U.S. are built with public funds and are free to users, as roads have been viewed as a socially beneficial activity. The rationale is based on the fact that roads facilitate economic activity while also providing linkage between communities and access for citizens to vital services. This justifies the use of public funds to pay for construction and maintenance. In many instances, tolls for the use of roadways and bridges have been collected to defray all or part of the costs (particularly to cover the cost of maintenance).

In recent years renewed interest in toll roads in the U.S. has grown for a two reasons:

   a. Toll collection provides a mechanism for financing construction and maintenance for new roads. In states and regions facing budget problems and limited debt capacity, toll roads offer a welcome source of external financing.

   b. Technological innovations are increasingly making possible an effective use of time-of-day pricing on toll roads to control and mitigate problems of congestion.

The key economic benefits attributed to toll roads arise from the second factor – mitigation of congestion problems implies time savings as well as energy savings. The importance of this cannot be overstated, as time and energy are two critical resources.
B. A Study of TCA Toll Roads

The Transportation Corridor Agencies (TCA) were formed in 1986 in a strategic effort to address the serious and increasing traffic congestion in Orange County. TCA was tasked with designing and developing a network of toll roads in Orange County. At the time TCA’s toll road system was proposed, a number of issues were raised regarding their potential benefits and costs. Now, twenty years after the project began, sufficient data have been collected to allow a quantification of the benefits and costs of TCA’s toll road system.

The purpose of this study is to examine the use of TCA’s toll roads and to provide quantitative and qualitative estimates of their economic impact. Based on data collected by the toll road agencies and the California Department of Transportation, it is estimated that more than 300,000 trips take place each day on the toll roads.

This study is organized in four sections:

- In Part I, we lay the economic foundation for evaluating the benefits arising from pricing roads generally and from toll roads specifically.
- In Part II, we provide an overview of TCA’s toll road system, including usage and toll revenues.
- Estimates of the time savings and other benefits from the toll roads are presented in Part III.
- Our conclusions are summarized in Part IV.

C. Key Findings

**TCA Toll Roads save drivers:**

- **Over $182 million a year** from the travel time saved as a result of reduced traffic congestion during just the daily peak periods;

- **Over 2 million gallons of gasoline per year** as a result of improved fuel efficiency;

- **Over $7 million per year** in total savings from improved fuel efficiency.
I. Economic Concepts

A. The Economics of Toll Roads

Most roads in the United States are built with public funding and provided to users free of charge. Throughout our country’s history, the construction of roads has usually been viewed as a socially beneficial activity, thereby justifying the collection of public funds to pay for construction and maintenance. Roads provided the necessary means for trade to occur, and those towns that aggressively built them were more likely to flourish.1

In many instances, tolls for the use of roadways have been collected to defray all or part of the costs (particularly to cover the cost of maintenance). For example, bridges may charge tolls to cover the high cost of construction and maintenance.

More recently, interest has grown in toll roads for a two-fold purpose. First, toll collection provides a mechanism for financing construction and maintenance for new roads. In states and regions facing budget problems and limited debt capacity, toll roads can offer access to outside financing. Second, technological innovations are increasingly making possible an effective use of time-of-day pricing on toll roads to control and mitigate problems of congestion.

Many of the economic benefits attributed to toll roads arise from this second factor – mitigation of congestion problems. In this section, we discuss the background and insights from economic theory regarding the benefits that can be attained from toll roads as a result of technological advances.

A.1 – Traffic Congestion: An Economic Market Failure

An important branch of economic theory attempts to explain potential market failures that arise because of “externalities.” The term “externality” is used by economists to denote situations in which the production or consumption of a good has impacts on others that are not taken into consideration in the production or consumption decision. For example, in the case of roads, a decision by a driver to use the road can impose externalities on other drivers if his or her presence creates congestion and slows the speed at which those others can travel.

Externalities are assumed to arise as a result of factors that cause this “market failure.” A primary cause of market failures is the existence of poorly defined property rights and high transactions costs.2 Road congestion occurs because of both of these conditions.

First, in the case of property rights, roads exhibit a characteristic sometimes referred to as public goods. Such items have the characteristic of being “non-rival” in consumption, that is, if one person consumes the product, others still can do so. In the case of a road, multiple users can use the same portion of road at different times without cost to others. As long as no congestion occurs, the addition of another vehicle does not impose costs on those otherwise using the road.

The second challenge in the case of roads involves transactions costs. The problem of congestion can be eliminated through contracts among parties only if (a) someone is granted the ownership right to the road, and (b) those wishing to use the road can negotiate a price for access. Given the problems of identifying users and making determinations about who uses the road when and at what price, the costs of these negotiations make a market solution infeasible.

---

Toll roads have attempted to solve this transaction cost problem by charging tolls to those who voluntarily want to use the facility. In some cases, including some of TCA’s toll roads, tolls differ during the day, with higher rates charged during peak use periods. This peak-period pricing attempts to reduce congestion by encouraging those who have more flexibility to change their time of use or to reduce unnecessary trips. Still, existing toll roads tend to create transactions costs in the form of delays at toll plazas that reduce their public acceptance.

A.2 – Technology: A Solution to Market Failures

Technology can play a part in reducing transactions costs and allowing market solutions to emerge. Transactions costs associated with toll collections have been traditionally high because of delays imposed on motorists. Moreover, in most cases, toll collections do not change to match traffic conditions and many simply charge the same at all times. This failure to adjust prices to demand conditions eliminates an important property of road pricing – pricing that matches supply with demand and sends signals to those who can delay or eliminate trips to do so, while having those using the road pay the full cost of the privilege.

Recent advances in toll road technologies, however, open the possibility of significant improvements in road use. As discussed by Peter Samuel, emerging technologies have made it possible at very low cost to effectively price roads without large transactions costs:3

- Electronic toll collection systems (e.g. FasTrak) allow drivers to pass through toll booths at high speed and bill the drivers remotely. Moreover, many systems interact, allowing transponders to work on the San Francisco Bay Bridge as well as on toll roads in Orange County.

- Optical pattern-matching technologies are being used in some locations (in Orange County and Toronto, for example), which can read license plates at high speeds and bill drivers.

- Combinations of electronic toll collection radio frequency identification (RFID) and optical technologies are providing the basis for future migration away from toll booth plazas.

- Smart cards or “electronic purses” also are being tried in Singapore, Japan, and Europe to directly pay tolls without the need to develop and maintain sophisticated databases for billing.

- Moreover, the technologies being developed in wireless communications will allow a device in the vehicle (similar to a GPS device) to constantly interact with roadside monitors, with the potential to (a) broadcast prices that change with congestion, and (b) automatically bill the driver’s account.

In many cases, these innovations raise concerns about privacy, but most organizations have found mechanisms to mitigate those issues, and legal protections can be built into data collection procedures. Moreover, smart cards or prepaid cards eliminate the need to collect and retain data for billing purposes.

A.3 – Profile of FasTrak Toll Collection Technology

In 1990, California became the first state in the nation to require all bridges and toll roads throughout the state to use the same electronic toll collection (ETC) system. With the opening of the Foothill Toll Road in 1993, Orange County’s Transportation Corridor Agencies launched the state’s first ETC system dubbed “FasTrak.” TCA holds the copyrights to the FasTrak name and logo.

FasTrak uses radio frequency identification technology to detect vehicles with FasTrak transponders as they pass through toll gates at speeds up to 70 mph. A FasTrak transponder is a small plastic RFID unit slightly bigger than a deck of cards that is typically affixed to the inside of a vehicle’s windshield. Each FasTrak transponder corresponds to a pre-paid toll account from which tolls are deducted.

FasTrak has now been successfully implemented on all TCA toll roads, on all of the bridges in the San Francisco Bay Area, on the Express Lanes of CA-91 in Orange County and the HOV toll lanes of I-15 in the San Diego area.
B. Advantages of Road Pricing

In the view of many economists and transportation experts, toll roads, and pricing roads more generally, offer important advantages in transportation. At present TCA realizes some of the benefits of road pricing by raising funds to pay for construction and using some peak period pricing to manage congestion. Moreover, the technology exists and can be employed in the future to take advantage of more of the potential advantages, should they choose to do so. Key among these are:

- **Efficiency**: Toll roads, when used to reduce congestion through charges that reflect current utilization, send signals to consumers about the full cost of using the road. This includes not only wear-and-tear costs, but the costs imposed by an additional driver on the travel speed of all other drivers. Toll pricing allows for rational decisions on the part of consumers – they can choose to avoid unnecessary trips and to time-shift trips to less congested times. A 1995 study of California roadways found that current congestion is under-priced by a factor of nine, while prices at uncongested times are twice the appropriate level.4

- **Building the Right Facilities**: Without proper price signals (including lack of any direct charges), building expensive new urban roadways leads to continually increasing congestion. In the absence of proper pricing, this result is likely. With pricing, however, the over-use of a facility is kept in check, and if congestion rises, prices rise.

- **Providing Funding**: If congestion rises, prices rise and provide the mechanism (and signal) to fund the project. Bond financing can be raised to pay for the project, with the future toll collections used as collateral.

- **Reducing Sprawl**: Urban sprawl is the direct result of under-pricing roadways. If drivers were required to pay the true cost of using a roadway, there would be less incentive to keep moving further away from job centers.

- **Fairness**: Users pay for their use in proportion to their use. Where congestion charges (or time-of-day pricing) can be implemented, they pay for the cost they impose on each other through congestion.

- **Greater Safety**: According to studies, the accident rate on toll roads – where the flow of traffic is more even – is lower.5

- **Matching Costs and Benefits**: Most roadways are funded through gasoline excise taxes. These taxes do not measure costs imposed by driving – they fail to address differences in fuel economy and the maintenance cost imposed by different vehicle weights. A toll system charges for use directly.

- **Increased Fuel Economy**: By increasing the overall capacity of a region’s transportation system, toll roads are able to absorb some of the traffic that would otherwise use non-toll highways and interstates. The result is a decrease in overall traffic congestion. Vehicles on both toll and non-toll roadways are able to move at more fuel efficient speeds.

---


5 Peter Samuel, November 2000
II. Overview of TCA Toll Roads

A. History of TCA Toll Roads

Faced with a growing population and increasing regional development in the early 1980s, Orange County was challenged with the need for additional freeway capacity. At that time, though, gas tax revenues were down due to the popularity of fuel-efficient cars in the wake of extended oil crises. Local, state and federal funds for transportation were committed to roadway maintenance – little money was available for new highway projects.

The Transportation Corridor Agencies (TCA) were formed in 1986 for the purpose of planning, financing and building the state’s first (and currently only) fee-for-use highways – commonly referred to as “toll roads” – in Orange County. In 1987, TCA was authorized to fund these projects through the sale of bonds to private investors to be repaid by toll revenues and local development impact fees. This network of state-owned toll roads is now made up of the San Joaquin Hills Toll Road (TR-73), the Foothill Toll Road (TR-241) and the Eastern Toll Roads (TR-241, TR-133 and TR-261). Like every other state-owned freeway and highway, TCA’s toll roads were designed and built to comply with CalTrans specifications.

To manage day-to-day operations of the toll roads and to oversee the collection of tolls, TCA operates as two separate agencies: the San Joaquin Hills Transportation Corridor Agency (SJHTC), which oversees TR-73, and the Foothill/Eastern Transportation Corridor Agency (F/ETCA), which oversees TR-241, TR-261, and TR-133. Each agency is governed by a separate board of directors made up of officials from fifteen cities and county supervisorial districts.

- F/ETCA member agencies are the cities of Anaheim, Dana Point, Irvine, Lake Forest, Mission Viejo, Orange, Rancho Santa Margarita, San Clemente, San Juan Capistrano, Santa Ana, Tustin, Yorba Linda, plus the County of Orange 3rd, 4th and 5th Districts.
- SJHTCA member agencies are the cities of Aliso Viejo, Costa Mesa, Dana Point, Irvine, Laguna Hills, Laguna Niguel, Laguna Woods, Mission Viejo, Newport Beach, San Clemente, San Juan Capistrano, Santa Ana, plus the County of Orange 3rd and 5th Districts.

Together, these two agencies employ approximately eighty people. In addition, the agencies carry out construction and maintenance projects through various public/private partnerships with local contractors.

In 2002, the Public Policy Institute of California and U.C. Irvine surveyed Orange County residents as to their opinion of the region’s toll road system. Over 65% responded positively to the toll roads and over 77% percent felt that the toll roads provided traffic congestion relief.6 A follow-up study by Decision Research in 2003 found that 66% of local residents were in favor of the toll roads.7

---

6 “2002 PPIC Statewide Survey: December 2002 Special Survey of Orange County,” Public Policy Institute of California in collaboration with the University of California, Irvine
B. Overview of the TCA Toll Road System

The existing toll roads operated by the Transportation Corridor Agencies in Orange County represent fifty-one miles of a proposed sixty-seven mile network of roadways. (Figure 1) The system is made up of three operational corridors: 1) the San Joaquin Hills Transportation Corridor, 2) the Foothill Transportation Corridor, and 3) the Eastern Transportation Corridor.

Figure 1
Orange County Transportation Corridor System

B.1 - The San Joaquin Hills Transportation Corridor

Completed in November 1996, the San Joaquin Hills Toll Road (TR-73) extends fifteen miles from Newport Beach to San Juan Capistrano in southwest Orange County. TR-73 offers a north-south alternative to I-405 and I-5.

---

For this study, we use the designation "TR-XX" to quickly and clearly identify TCA toll roads for the reader and "CA-XX" to identify other non-toll state routes. We acknowledge that the standard designation for both is "SR-XX."
B.2 - The Foothill/Eastern Transportation Corridor

The Foothill/Eastern Transportation Corridor consists of three segments: the Foothill North corridor (the northern segment of TR-241), the Eastern corridor (TR-261 and TR-133), and the proposed Foothill South corridor (the southern segment of TR-241).

- The Eastern Corridor begins at the Riverside Freeway (CA-91) and parallels the Costa Mesa Freeway (CA Route 55) east of Anaheim Hills, Orange, and Tustin, then splits into two legs (TR-261 and TR-133). The Eastern Toll Road (TR-133) connecting Foothill North with Interstate 5 opened in 1998. The west leg of the Eastern Toll Road (TR-261) connecting Foothill North with Interstate 5 opened in 1999.
- The first 3.2-mile segment of the Foothill Toll Road (TR-241) opened in Oct. 1993, the second 3.2-mile extension between Antonio Parkway and Oso Parkway opened in 1999.
- Construction of the remaining link - the Foothill South corridor - between the current southern end of TR-241 at the Oso Parkway and Interstate 5 south of San Clemente is planned for 2007-2008 with completion targeted at 2010-2011.

C. Usage of TCA Toll Roads

Usage of the toll roads has increased substantially from the late 90s with a brief period of slow growth during the 2001-2003 economic slowdown. (Figures 2 and 3) Growth rebounded in 2004 with the recovery and increased again in 2005. On an average day, between 27,000 and 44,000 vehicles use TR-241. An average of 65,000 vehicles travels TR-73 each day, while roughly 14,000 vehicles use TR-261 and 34,000 use TR-133 daily. In 2005, traffic on the toll roads was up 4.9% over 2004 and up 16.2% over 2001. (Figure 4)

TCA toll roads currently handle 6% of the county’s traffic (including highways and interstates not included in our analysis) while the non-toll highways and interstates handle over 80% of Orange County’s traffic. A profile of the non-toll highways and interstate segments that benefit from the congestion relief provided by TCA toll roads is illustrated in Figure 5. Here we show segment lengths and travel times at the non-congested free flow rate of 65 mph.

(See Appendix for traffic volume data, assumptions and methodology)

---

9 CalTrans
10 UC Berkeley Institute for Transportation Studies
**Figure 4**

Toll Road Transactions - 2005

<table>
<thead>
<tr>
<th></th>
<th>2005</th>
<th>Growth over 2004</th>
</tr>
</thead>
<tbody>
<tr>
<td>Average Daily Transactions</td>
<td>172,684</td>
<td></td>
</tr>
<tr>
<td>Average Weekly Transactions</td>
<td>1,808,440</td>
<td></td>
</tr>
<tr>
<td>Total Annual Toll Transactions</td>
<td>94,038,882</td>
<td>+4.9%</td>
</tr>
</tbody>
</table>

Source: Transportation Corridor Agencies

**Figure 5**

Profiles of Traffic along TCA Toll Roads:
Segment Lengths and Travel Times at Free Flow Rate of 65 mph

Segment: 7.5 miles
Travel Time: 6.4 minutes

Segment: 5.5 miles
Travel Time: 4.7 minutes

Segment: 3.0 miles
Travel Time: 2.6 minutes

Segment: 7.5 miles
Travel Time: 6.4 minutes

Segment: 1.5 miles
Travel Time: 1.3 minutes

Segment: 8.5 miles
Travel Time: 7.3 minutes

Segment: 9.0 miles
Travel Time: 7.7 minutes

Source: CalTrans, LECG
D. Toll Structure

The Toll Roads collect tolls on all vehicle traffic from motorcycles to multi-axle trucks. In fiscal year 2005, more than 94 million toll transactions were recorded.\textsuperscript{11} (Figure 6) Money collected at the toll gates is used primarily to repay the non-recourse bonds that were issued to build the roads.

D.1 - Toll Pricing

- Tolls for passenger cars that use the Toll Roads ranges between 25 cents to $4.25 depending on the segment traveled and the time of day. Most of the toll segments charge a fixed rate throughout the day, seven days a week.

- Two segments (Catalina View and Tomato Springs) charge higher tolls during peak hours (M-F northbound 7 to 9 am and southbound 4 to 7 pm). The Catalina View segment also offers a discounted toll rates on weekends. There are no “carpool” discounts on the Toll Roads.

D.2 - Toll Collection

- The Toll Roads have very effectively implemented FasTrak automatic toll collection throughout the system. Roughly two-thirds of all toll transactions are through the FasTrak system. (Figure 7)

- FasTrak allows vehicles to pass through any of the system’s toll gates without stopping. Special FasTrak-only lanes are designated to facilitate FasTrak traffic.

- The FasTrak system uses transponders that uniquely identify each driver. Drivers are charged $1 per month for the use of a transponder (this fee is waived when a vehicle incurs more than $25 in tolls during the month). A transponder can be used on more than one vehicle as long as each vehicle’s license number is on file with the driver’s account.

- FasTrak monitors at the system’s toll gates record vehicle passage through toll gates, then automatically deduct tolls from prepaid user account.

- Throughout the system, FasTrak tolls are less than cash toll rates in order to provide an incentive to use the FasTrak system.

Figures 6 and 7 provide details on the toll structure and toll collection systems. Figure 6 shows the percentage of FasTrak transactions per year from 2001 to 2005. Figure 7 shows the total number of FasTrak transactions in 2005.

\textsuperscript{11} Transportation Corridor Agencies
**E. Toll Road Revenues**

Revenue from TCA’s toll roads now tops $167 million per year. Total toll receipts in 2005 were 9.8% higher than in 2004 and over 35% higher than in 2001. (Figure 8)

- Revenue from the Foothill/Eastern Toll Roads grew very slowly through 1998, then jumped significantly in 1999 with the opening of the Eastern segment. Since then, revenue has increased steadily – 2005 revenue was up 7.1% over 2004 and up over 25% since 2001. (Figure 9)

- Revenue from the San Joaquin Hills Toll Roads jumped significantly between 1997 (the first full year opened) and 1998. Since then, toll revenue has continued to grow steadily – 2005 tolls were up 12.8% over 2004 and up over 48% since 2001. (Figure 10)

---

**Figure 8**

Orange County Transportation Corridor Agencies
Toll Road Revenue
Annual Data, 2001 to 2005

![Figure 8](image)

**Figure 9**

Total Revenue
Foothill/Eastern Toll Roads (SR-241, SR-261, SR-133)
Annual Data, 1997-2005
($ millions)

![Figure 9](image)

**Figure 10**

Total Revenue
San Joaquin Hills Toll Road (SR-73)
Annual Data, 1997-2005
($ millions)

![Figure 10](image)

Sources: CalTrans, Transportation Corridor Agencies
III. Economic Benefits of TCA’s Toll Roads

A. Impacts of Traffic Congestion

A 1994 report from the U.C. Berkeley Institute for Transportation Studies notes that “the impacts of congestion indicate that its price is quite high.” This report enumerates a variety of impacts:

1. Delays and unreliable travel times
2. Inefficiencies in vehicle operations (e.g. excessive fuel consumption)
3. Reductions in levels of comfort and convenience
4. Reduced safety (e.g. more bumper-to-bumper accidents)
5. Increases in automobile insurance premiums (based on more incidents)
6. Health impairment (e.g. increased stress, increased incidents of asthma and other respiratory diseases caused by breathing higher concentration of fumes)
7. Reduced business productivity and economic vitality
8. Inefficiencies in operation of transportation systems (e.g. goods movement)
9. Environmental damage (e.g. increased emission levels)

For our study, we focused specifically on 1) the economic benefits of congestion reduction as measured by time savings and fuel savings, and 2) other economic impacts on individuals and businesses.

B. Toll Roads Reduce Traffic Congestion

What would the traffic conditions be on Orange County’s non-toll highways and interstates if TCA’s toll roads did not exist? In order to measure the impact of shifting toll road traffic onto the adjacent non-toll roadways, the highest measured peak hour vehicle traffic along a toll road segment was projected onto nearby non-toll highway and interstate segments.

Figure 11 shows the increase in overall peak and average daily traffic volume along selected segments. Data presented here shows increases in traffic and travel times at the measured peak hour (typically late afternoon return commute hour). As congestion increases, drivers will by nature alter their departure times to adjust for the additional congestion. As a result, peak traffic may not reach the levels noted, but the “rush hour” will be extended both before and after the given hour. Extended peak traffic will have additional negative impacts. We acknowledge that traffic shift may be asymmetric with more impact in one direction.

When viewed by highway segment, it is clear that the county’s toll roads handle a much larger share of local highway traffic. For example, I-405 would carry 26% more peak traffic were it not for the traffic diverted to TR-73. And the Zone C peak traffic along I-5 would increase by over 50% were it not for TR-241 and TR-73. Figure 6 illustrates a summary of our estimates of the increase in traffic along the region’s non-toll highways and interstates if TCA’s toll roads were not available for traffic diversion.

Our analysis confirms the benefits of TCA’s toll road system as determined by a previous impact study conducted by Austin-Foust Associates in 2001, a traffic engineering firm. This study found that without TCA’s toll roads, “congestion periods at key freeway choke points would increase 3 to 25 percent, and from 4 to 69 percent on major arterial roads. Collectively, the toll roads reduce congestion by an estimated 20% along I-5 in the county.”

Figure 11
Increases in Peak Hour and Average Annual Daily Traffic
Without Orange County Toll Roads - 2004

Source: CalTrans

---

13 Austin-Foust Associates, 2001
14 Transportation Corridor Agencies
CalTrans defines the peak capacity of a single highway lane as 2,200 vehicles per hour. Figure 12 profiles the current peak traffic along selected segments of non-toll highways for which the region’s toll roads provide traffic relief.

**Figure 12**

**Current and Projected Peak Traffic Volume per Lane**

(vehicles per lane per hour)

Highlighting indicates over-capacity traffic levels

<table>
<thead>
<tr>
<th>ZONE</th>
<th>Current Peak Traffic w/o Toll Roads</th>
</tr>
</thead>
<tbody>
<tr>
<td>A</td>
<td>CA-55 to CA-22 1,430 1,716</td>
</tr>
<tr>
<td></td>
<td>CA-91 to CA-55 2,088 2,401</td>
</tr>
<tr>
<td>B</td>
<td>CA-55 to I-5 1,485 1,841</td>
</tr>
<tr>
<td></td>
<td>I-5 to TR-133 2,431 2,772</td>
</tr>
<tr>
<td>C</td>
<td>I-5 to End 2,299 3,448</td>
</tr>
<tr>
<td>D</td>
<td>CA-55 to I-405 1,690 1,893</td>
</tr>
<tr>
<td></td>
<td>I-405 to I-5 2,797 3,524</td>
</tr>
</tbody>
</table>

Figure 12 clearly shows that CA-91, I-405 and I-5 are currently at or above maximum capacity during peak hours. This does not mean that these highways cannot accommodate additional vehicles, it simply means that additional vehicles will create congestion leading to slower speeds and longer travel times. Drivers will tolerate some level of congestion particularly when it is predictable. But when congestion slows traffic beyond an acceptable level, some drivers will seek alternative routes.

Figure 12 also shows the projected peak traffic volume per lane if TCA’s toll roads didn’t exist. What we find is that in most cases, traffic volume along CA-91, I-405 and I-5 is pushed into serious congestion conditions. When these higher traffic volume levels are translated into decreased speeds and increased travel time, we find that traffic along I-405 and I-5 without the toll roads would literally come to a complete stop.

Needless to say, it is unlikely that such gridlock would occur because some drivers experiencing these conditions or being informed of these conditions would seek alternative routes. Basically this means that some of the highway congestion would be shifted to surface streets, particularly on the region’s parkways and primary traffic arteries. As drivers along those arteries experienced greater congestion and delays, some would seek other alternatives along smaller streets. At some point, equilibrium in traffic volume would be established between the highways and surface streets that would result in widely distributed congestion with every driver experiencing slower speeds and longer travel times. Figures 13 summarizes the increases in travel time and decreases in speed that would be experienced on selected highway and interstate segments were it not for the county’s toll roads. Figure 14 illustrates projected travel time increases along specific highway segments. While the impact on CA-55 appears minimal, the impacts on I-5 and I-405 are significant.
Note: For Figures 13 and 14 and for our analysis, we factored driver behavior into our estimates of both travel times and congested speeds without toll roads. Also note that speed estimates are based on no other causes of congestion – e.g. due to weather, accidents, rubber-necking, etc. These factors almost always exist and negatively impact speeds, travel times and fuel efficiency.

### Figure 13
**Impact of Toll Road Traffic on Non-Toll Highways & Interstates at Peak**

<table>
<thead>
<tr>
<th>Segment</th>
<th>Travel Time at Peak</th>
<th>Speed at Peak</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Minutes with TR</td>
<td>Minutes w/o Toll Roads</td>
</tr>
<tr>
<td>CA-55 to CA-22</td>
<td>5.1</td>
<td>5.2</td>
</tr>
<tr>
<td>CA-91-CA-55</td>
<td>8.5</td>
<td>13.0</td>
</tr>
<tr>
<td>CA-55 to I-5</td>
<td>2.8</td>
<td>2.95</td>
</tr>
<tr>
<td>I-5 to TR-133</td>
<td>13.8</td>
<td>31.9</td>
</tr>
<tr>
<td>I-5 to End</td>
<td>12.4</td>
<td>35.9</td>
</tr>
<tr>
<td>CA-55 to I-405</td>
<td>1.4</td>
<td>5.6</td>
</tr>
<tr>
<td>I-405 to I-5</td>
<td>41.1</td>
<td>66.0</td>
</tr>
</tbody>
</table>

* Times adjusted down based on some driver diversion to surface streets due to excessive delays

Source: CalTrans, LECG
C. Economic Benefits of Congestion Reduction

The California Department of Transportation (CalTrans) regularly collects traffic data from its extensive network of sensors embedded at key points and access ramps throughout the state’s highway system. Data is summarized and reported as peak hour traffic and average annual daily traffic. These numbers can be used to determine traffic patterns and congestion levels along selected highway segments.

For this analysis, 2004 traffic data from CalTrans was collected and analyzed to determine the impact on the region’s state highways and interstates were there no toll roads to divert some of the daily traffic. Traffic congestion as measured by increased travel time for each segment was charted using formulas developed by the U.S. Department of Transportation’s Bureau of Public Roads15.

To estimate the time savings benefits from TCA’s toll roads, we first estimated the potential increase in travel time for all drivers had the toll roads not been built. Next, we applied empirical estimates of the value of time to compute a dollar value of time saved.

To estimate the time savings from the toll roads, we used the CalTrans data on traffic along non-toll highways and interstates potentially affected at peak and average daily rates discussed above. We then took peak hour vehicle volume from the toll roads and apportioned those vehicles to the most logical alternative non-toll road by zone. Finally, using formulas from the U.S. Department of Transportation, we estimated the impact on average travel times for adding these new drivers to the existing roadways.

<table>
<thead>
<tr>
<th>Zone/Segment</th>
<th>Total Peak Hour Travel Time Reduction</th>
</tr>
</thead>
<tbody>
<tr>
<td>Zone A</td>
<td></td>
</tr>
<tr>
<td>CA-55</td>
<td>238 minutes</td>
</tr>
<tr>
<td>CA-91</td>
<td>10,953 minutes</td>
</tr>
<tr>
<td>Zone B</td>
<td></td>
</tr>
<tr>
<td>CA-55</td>
<td>294 minutes</td>
</tr>
<tr>
<td>I-5</td>
<td>50,065 minutes</td>
</tr>
<tr>
<td>Zone C</td>
<td></td>
</tr>
<tr>
<td>I-5</td>
<td>62,554 minutes</td>
</tr>
<tr>
<td>Zone D</td>
<td></td>
</tr>
<tr>
<td>CA-55</td>
<td>215 minutes</td>
</tr>
<tr>
<td>I-405</td>
<td>67,292 minutes</td>
</tr>
<tr>
<td><strong>Total Peak Hour Minutes Saved:</strong></td>
<td><strong>191,611 minutes</strong></td>
</tr>
<tr>
<td><strong>Total Peak Hour Hours Saved:</strong></td>
<td><strong>3,193 hours</strong></td>
</tr>
</tbody>
</table>

Source: LECG

The total time and cost savings estimates attributable to the toll roads during peak periods are shown in Figure 15. In the absence of the toll roads, aggregate travel time for vehicles on non-toll highways and interstates would have increased by 3,193 hours during peak hours.

Assuming an average ridership of 1.27 persons/car, a total time savings of 4,055 hours during a peak hour can be projected.16 (Figure 16)

<table>
<thead>
<tr>
<th>Estimated Value of Time Savings</th>
<th>Hours</th>
<th>Value ($30/hr)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total time saved per peak hour (hours)</td>
<td>3,193</td>
<td></td>
</tr>
<tr>
<td>Number of persons per car</td>
<td>x1.27</td>
<td></td>
</tr>
<tr>
<td>Person hours saved per peak hour (hours)</td>
<td>4,055</td>
<td>$121,650</td>
</tr>
<tr>
<td>Number of rush hours/day</td>
<td>x 6</td>
<td></td>
</tr>
<tr>
<td>Total daily person hours</td>
<td>24,330</td>
<td>$729,900</td>
</tr>
<tr>
<td>Annual hourly savings:</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Days/year</td>
<td>x 250</td>
<td></td>
</tr>
<tr>
<td>Annual person hours</td>
<td>6,082,665</td>
<td>$182,479,950</td>
</tr>
</tbody>
</table>

Source: LECG

For our calculations, we assume that “peak hour” congestion is in fact a two-hour period and that 50% of the time cost calculated above would be present in the hour before and the hour after the peak period. Therefore, peak congestion will span a three-hour period. In the course of a day, there are typically two peak traffic periods. This then results in a total of six hours of peak traffic congestion per day.

Based on six hours of peak congestion per day, we arrive at a daily peak congestion time savings of nearly 24,000 hours per day. On an annual basis, assuming 250 congested days per year,17 we estimate that TCA toll roads contribute a total time savings of over six million person-hours per year.

Several studies have attempted to quantify the value of time savings. A recent study based on survey information from TCA’s toll roads arrived at values ranging from $7 to $65 depending on motorist characteristics, with an average value of time of $30 per hour.18 Using that estimate, the value of time saved by commuters attributable to TCA toll roads during congested periods is over $182 million per year. (Figure 16) Moreover, this understates the value of the toll roads since it only considers time saved during peak congestion periods.

---

17 Ibid.
D. Improved Fuel Efficiency

Of the various impacts of congestion outlined by U.C. Berkeley Institute for Transportation Studies researchers, increased fuel consumption has the most visible and direct economic impact on individual drivers. In order to demonstrate the significant decrease in fuel efficiency resulting from a decrease in traffic flow to congested conditions, we used the following formula:

Average Fuel Efficiency (mpg) = 8.8 + [0.25 x (Average Speed)]

Using this formula, we can calculate the average fuel efficiency at various speeds. (Figure 17)

Note: for Figure 17 and for our analysis, we factored driver behavior into our estimates of both travel times and congested speeds without toll roads.

Figure 17
Fuel Efficiency with and without Toll Roads

<table>
<thead>
<tr>
<th>ZONE A</th>
<th>Miles per Gallon</th>
<th>Fuel Use</th>
<th>Cost per Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
<td>MPG</td>
<td>Decrease</td>
</tr>
<tr>
<td>CA-55</td>
<td>CA-22</td>
<td>25.0</td>
<td>-48.5%</td>
</tr>
<tr>
<td>CA-91</td>
<td>CA-55</td>
<td>22.1</td>
<td>-42.7%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONE B</th>
<th>Miles per Gallon</th>
<th>Fuel Use</th>
<th>Cost per Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
<td>MPG</td>
<td>Decrease</td>
</tr>
<tr>
<td>CA-55</td>
<td>I-5</td>
<td>24.9</td>
<td>-48.4%</td>
</tr>
<tr>
<td>I-5</td>
<td>TR</td>
<td>13.9</td>
<td>-28.8%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONE C</th>
<th>Miles per Gallon</th>
<th>Fuel Use</th>
<th>Cost per Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
<td>MPG</td>
<td>Decrease</td>
</tr>
<tr>
<td>I-5</td>
<td>End</td>
<td>19.1</td>
<td>-35.4%</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONE D</th>
<th>Miles per Gallon</th>
<th>Fuel Use</th>
<th>Cost per Segment</th>
</tr>
</thead>
<tbody>
<tr>
<td>From</td>
<td>To</td>
<td>MPG</td>
<td>Decrease</td>
</tr>
<tr>
<td>CA-55</td>
<td>I-405</td>
<td>24.6</td>
<td>-47.8%</td>
</tr>
<tr>
<td>I-405</td>
<td>I-5</td>
<td>12.1</td>
<td>-10.3%</td>
</tr>
</tbody>
</table>

Source: LECG

It is clear that with the addition of toll road traffic on the non-toll highways, fuel efficiency is decreased from 10% to almost 50%. Note that the smaller decrease in fuel efficiency along I-405 in Zone D is due to the already slow and congested speeds along that segment. These figures are conservative in that the actual figures for per lane traffic volume push congestion to total gridlock in some cases, therefore based on anticipated driver behavior, we have applied only a portion of the toll road traffic onto the non-toll highways. Traffic and therefore fuel efficiency along alternative routes (surface streets) will be seriously impacted were the toll roads not available to relieve congestion.

The fuel savings resulting from the toll road’s impact on reducing congestion are significant. Using the estimated changes in speed for each segment, and the formulas translating speed changes into fuel economy, we have estimated the total cost and fuel savings attributable to the toll roads. For this analysis, we used the following simplifying assumptions:

- Gasoline price of $3.25 per gallon
- 250 days per year
- 6 hours of peak congestion each day
- A maximum of 2,700 vehicles per lane mile

As shown in Figure 18, we estimate a total savings from improved fuel economy of over $7 million per year. This also translates into a fuel savings of over 2 million gallons per year.

**Figure 18**
Calculation of Fuel Savings

<table>
<thead>
<tr>
<th>ZONE A</th>
<th>Traffic Volume</th>
<th>Additional Fuel Costs</th>
<th>Additional Fuel Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riders</td>
<td>Adjusted</td>
<td>6 hours</td>
</tr>
<tr>
<td>CA-55 to CA-22</td>
<td>1,716</td>
<td>1,716</td>
<td>10,296</td>
</tr>
<tr>
<td>CA-91 to CA-55</td>
<td>2,401</td>
<td>2,401</td>
<td>14,406</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONE B</th>
<th>Traffic Volume</th>
<th>Additional Fuel Costs</th>
<th>Additional Fuel Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riders</td>
<td>Adjusted</td>
<td>6 hours</td>
</tr>
<tr>
<td>CA-55 to I-5</td>
<td>1,841</td>
<td>1,841</td>
<td>11,048</td>
</tr>
<tr>
<td>I-5 to TR-133</td>
<td>2,772</td>
<td>2,700</td>
<td>16,200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONE C</th>
<th>Traffic Volume</th>
<th>Additional Fuel Costs</th>
<th>Additional Fuel Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riders</td>
<td>Adjusted</td>
<td>6 hours</td>
</tr>
<tr>
<td>I-5 to End</td>
<td>3,448</td>
<td>2,700</td>
<td>16,200</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>ZONE D</th>
<th>Traffic Volume</th>
<th>Additional Fuel Costs</th>
<th>Additional Fuel Use</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Riders</td>
<td>Adjusted</td>
<td>6 hours</td>
</tr>
<tr>
<td>CA-55 to I-405</td>
<td>1,893</td>
<td>1,893</td>
<td>11,357</td>
</tr>
<tr>
<td>I-405 to I-5</td>
<td>3,524</td>
<td>2,700</td>
<td>16,200</td>
</tr>
</tbody>
</table>

|               | Daily Totals:  | $28,470.85 | 8,760.3 |
|               | Annual Savings: | Fuel Cost: $7,117,713.26 | Gallons: 2,190,065.6 |

Source: LECG
E. Other Economic Benefits

E.1 - Increased Property Values

In addition to increasing convenience and decreasing the costs of travel, property values in the neighborhoods that have easy access to TCA toll roads have increased more than in other areas of the region.

A recent study by the Brookings Institute Center found that the construction of the first two portions of TCA’s toll road network created accessibility premiums that were reflected in home sales prices.20 A follow-up study by the University of California at Irvine21 showed that the construction of TCA’s toll roads, particularly the Foothill Transportation Corridor Backbone, created an accessibility premium that resulted in an increase in property values for homes in the service area of the toll roads. The study also concluded that “both the FTCBB and the SJHTC improved accessibility near the corridors in ways that home buyers valued. The evidence indicates that home buyers are willing to pay for the increased access the new road provided.”

E.2 - Benefits to Businesses

The U.C. Berkeley Institute for Transportation Studies report22 also outlines various impacts of congestion on business productivity and economic vitality. Based on their findings, TCA toll roads benefit the region’s businesses by:

1. Improving output and deliveries and decreasing missed appointments
2. Decreasing the need for inventory holdings to safeguard against potential future delays
3. Increased efficiency of commercial vehicle fleets resulting from better vehicle use
4. Less time lost from employees (i) arriving late to work resulting in the need for additional hires, over-time pay, or managing absenteeism, or (ii) taking sick leave due to congestion-induced health impacts
5. Increased desirability of the area for employees to live, making it easier to attract good employees.

It is not within the scope of this report to quantify the savings to businesses associated with the toll roads. Simply the savings in travel time for on-the-clock employees (e.g. sales people, truck drivers, delivery people, etc.) along with the decreased use of expensive fuel clearly provide direct bottom-line benefits for businesses, particularly small businesses (as are a majority of the businesses in this region).

In addition to direct savings for businesses, the toll roads also improved access to some of the region’s recreational and commercial areas with direct benefits for visitors and for local businesses. A May 2000 report by the City of Laguna Beach states: “This suggests that while the opening of the San Joaquin Toll road has increased access to Laguna Beach, it may also have relieved congestion during commuter hours by providing regional traffic with a more preferred route other than Laguna Canyon Road and Pacific Coast highway.”23

23 “Laguna Beach: At a Glance,” City of Laguna, May 2000
IV. Conclusions

It is clear from our analysis of the region’s traffic data that the existing system of non-toll highways and interstates has insufficient peak capacity to carry the full volume of traffic now handled by both the region’s toll and non-toll highways without a significant decrease in the level of service. TCA’s toll roads provide a critical diversion of traffic that generates a variety of economic benefits for individual drivers, businesses, tourists, and local homeowners.

Based on conservative estimates of the travel time saved during just the weekday peak traffic hours, we estimate the economic benefit of time savings from TCA’s toll roads to be at least $182 million per year not including additional savings in fuel and other vehicle operating costs. While toll road users may find their fuel costs offset by toll charges, they still benefit greatly from the travel time saved. Some of the cost of using the toll roads can be reduced by using FasTrak and by traveling during off-peak hours. Non-toll road drivers also benefit by the fact that fewer vehicles are on the non-toll highways and interstates during peak hours.

TCA’s toll roads represent a step in the direction of developing rational highway design. By providing economic incentives (and disincentives) for selected routes and travel times, the toll road system helps create a more efficient vehicle movement system throughout the region. Further implementation of toll roads and time-based toll pricing will contribute to more balanced highway usage and additional economic benefits.

TCA Toll Roads save drivers:

- **Over $182 million a year** from the travel time saved as a result of reduced traffic congestion during just the daily peak periods;

- **Over 2 million gallons of gasoline per year** as a result of improved fuel efficiency;

- **Over $7 million per year** in total savings from improved fuel efficiency.
Appendix

Methodology of Traffic Monitoring and Congestion Measurement

Measuring traffic flow and determining levels of congestion is a highly complex process. Over the years, CalTrans has installed a sophisticated network of sensors throughout the state’s highway system to provide detailed traffic data. The following are key points to help the reader understand where and how CalTrans collects its data to better understand how congestion levels are determined.

- Data collection points are mapped out along the entire length of a highway. Sensors are embedded at points before and after each mapped point. Sensor placement may be north or east of a monitoring point (designated by CalTrans as “Ahead”) or south or west of a monitoring point (designated as “Back”) depending on the directional flow of traffic. In many cases, data is collected at both an Ahead point and a Back point in order to capture traffic entering and leaving an interchange.

- Total traffic volume is a function of the total number of vehicles at any given time and the number of lanes over which that traffic is distributed. Sensor data collected at locations along a segment can vary by as much as 160% as cars enter and leave at various points. Generally, the variation ranged from approximately 9% to 51%. Truck traffic represents approximately 2% to 6% of the total traffic volume.

- When looking at the traffic data for a specific highway segment, one of the key issues in determining total traffic volume is the process by which vehicles are counted. One method is to sum the vehicle counts for all the measurement points along a segment. This method assumes that each vehicle crossing a monitoring point is unique when in fact, it is often likely that the same vehicle will cross more than one sensor as it proceeds along the segment.

Therefore, in order to be somewhat more accurate and more conservative in our estimates of traffic volume, we used the single highest peak hour vehicle count as measured along a given segment. Peak hour traffic volume is often used as the basis for determining levels of service and the impact of various conditions on congestion.

- CalTrans defines a highway’s maximum capacity as approximately 2,200 to 2,400 vehicles per hour per lane. Even at this maximum capacity, traffic can flow freely at speeds up to 70 mph if no congestion-causing conditions are present.

- Basically, highway congestion is caused when traffic demand approaches or exceeds the available capacity of the highway system. Caltrans defines congestion as occurring on a freeway when the average speed drops below 35 mph for 15 minutes or more on a typical weekday. Previous widely cited studies suggest that over 50 percent of freeway congestion is incident related. Further research has shown that only a fraction of reported incidents cause delay.

- Congestion occurs as the result of a variety of conditions - from poor weather and increased slope of the roadway to road maintenance and, of course, highway accidents. Any reduction in the free flow of traffic is considered a decrease in the “level of service” of the highway during those conditions.

---

24 CalTrans
25 “You Are the Traffic Jam: An Examination of Congestion Measures,” Robert L. Bertini, Department of Civil & Environmental Engineering, Portland State University, November 2005
As we approached the challenge of estimating the economic benefits of TCA’s toll roads, we took the perspective of determining the impact on adjacent non-toll highways and interstates. To do this, we looked at the network of toll and non-toll highways in the region, then projected current peak hour traffic from specific segments of the toll roads onto the adjacent non-toll highways and interstates by zone as we imagined the average driver would select. We did this by defining four zones and examined the impact of traffic shifts by zone (Figure 19).

Although we are using peak traffic data representing the vehicle traffic at a single monitoring point along a highway segment, the impact of shifting traffic from the toll roads to non-toll highways will have impact throughout the day. In fact, there are typically two peak hours per day (morning and late afternoon). With the addition of toll road traffic to adjacent non-toll highways, it is reasonable to estimate that “peak hour” traffic will be extended well beyond a specific hour. Our estimation is that, with additional traffic, “peak hour” will become an hour and a half or two hour period of peak congestion. It is also reasonable to estimate that traffic conditions before and after peak hour are at least 50% of peak hour levels.

Figure 19
Traffic Shift Patterns by Toll Road Segment and Zone

Source: CalTrans, LECG
CalTrans Traffic Data

Figure 20 provides a summary of the Peak Hour and Average Annual Daily traffic estimates from CalTrans that were used in our analysis. Data represented here (and used in this analysis) is the peak hour traffic volume as measured at only one of the measurement points of a segment. The measurement point selected for use was the point with the highest peak hour traffic volume. Figures shown are for traffic in both directions at the measurement point.

Figure 20
Traffic Flow along TCA Toll Roads, Public Highways and Interstates
CalTrans Data – 2004

<table>
<thead>
<tr>
<th>Zone A</th>
<th>Segment</th>
<th>Peak Hour / Average Annual Daily</th>
</tr>
</thead>
<tbody>
<tr>
<td>TR-241</td>
<td>5,900 / 45,000</td>
<td></td>
</tr>
<tr>
<td>CA-35</td>
<td>14,300 / 215,333</td>
<td></td>
</tr>
<tr>
<td>CA-91</td>
<td>18,980 / 283,600</td>
<td></td>
</tr>
</tbody>
</table>

Key:
- Zone B
  - TR-241: 7,100 / 44,000
  - TR-261: 2,533 / 14,700
  - TR-133: 3,511 / 34,444
  - CA-55: 14,850 / 235,250
  - I-5: 24,313 / 311,000

- Zone C
  - TR-241: 5,590 / 29,400
  - TR-73: 5,850 / 64,000
  - I-5: 22,988 / 289,625
Authors

Tapan Munroe, PhD

Tapan Munroe is well known in California and the U.S. for his economic and policy analysis consulting and advisory work. He is a Director of LECG, a worldwide consulting firm, and the Consulting Chief Economist for the Capital Corp of the West. Previously, Dr. Munroe served for more than a decade as the Chief Economist for the Pacific Gas & Electric Company.

He received his Ph.D. in Economics from the University of Colorado. He is also a graduate of the Executive Training Program of the University of Chicago. Dr. Munroe has been a visiting scholar at the Massachusetts Institute of Technology, the University of Augsburg in West Germany, and Stanford University. He has also taught at the University of the Pacific in Stockton and at the University of California, Berkeley. He held the Kiriyama Distinguished Professorship for Asia Pacific Studies at the University of San Francisco for 1998-99. He has also been a Senior Fellow of the Great Valley Center in Modesto.

Dr. Munroe has served as the President of the National Association of Business Economists (Bay Area chapter), a member of the National Petroleum Council Task Force on Oil Prices, and the quarterly Chair of the Commonwealth Club of California. Dr. Munroe is on the Board of Trustees of the University of California at Merced. He has been a Director of County Bank, Merced.

As a widely published author and a nationally known speaker, he has been a frequent commentator on regional and national radio and TV news programs. He has been a columnist on economic issues for the San Francisco Examiner and is currently a columnist for the Contra Costa Times (a Knight Ridder newspaper). His recent books include Public Power in California (Xlibris, 2003) and Dot-Com to Dot-Bomb – Understanding the Dot-Com Boom, Bust and Resurgence (Moraga Press, 2004).

Ronald Schmidt, PhD

Ronald Schmidt is a Principal at LECG, LLC. Since joining the firm in 1997, he has worked on a wide range of litigation engagements, specializing in cases involving economic expert testimony in antitrust claims, mergers, and the determination of damages, including breach of contract damages. He has previously served as the firm's Director of Marketing, Senior Recruiter, and Manager of the firm's professional staff.

Prior to joining LECG, Dr. Schmidt served as Vice President and Chief Financial Officer of Silver Fox Promotions, Inc., from 1994-1997, where he was responsible for incorporating the company and setting up and managing all financial planning, accounting, and information technology functions. He also has 12 years of research experience as a Senior Economist at the Federal Reserve Banks of Dallas and San Francisco, during which time he published extensively in the areas of energy, water, transportation, and regional economics as well as providing advice to the Banks’ Presidents regarding monetary policy.

Dr. Schmidt holds a Ph.D. and M.S. in Economics from the University of Wisconsin and a B.A. degree from the University of California at Davis.
Mark Westwind, MPA

Mark Westwind has over 30 years experience working with businesses, government agencies and non-profit organizations. He was the founding Director of the Contra Costa Software Business Incubator (CCSBI) in Concord and the founding Associate Director of John F. Kennedy University’s Center for Entrepreneurship. Internationally, Westwind served for four years as the U.S. Associate for Guangzhou-based Canton Venture Capital Company – a $100 million Chinese VC firm.

Westwind graduated from the University of California at Berkeley with a B.A. in Environmental Studies. He earned a Masters of Public Administration (MPA) degree and a Community College Instructor’s Credential at Cal. State University, Hayward. Westwind also holds a Certificate in Entrepreneurship from John F. Kennedy University.