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THE KEY FINDINGS

1. Traffic congestion has a negative effect on economic growth. The largest transportation problem for Texas, now and well into the foreseeable future, is the movement of people, goods, and services from point to point within the urban areas.

2. Texas's population will increase from 20.8 million in 2000 to as much as 36 million in 2025. Ninety percent of this growth, or as many as 14 million more people, will likely be in Texas's major metropolitan areas.

3. Traffic congestion is getting worse. From 1990 to 2000, while Texas's population grew by 23 percent, vehicle miles traveled increased by 41 percent, TxDOT spending increased by 45 percent, but the number of lane-miles increased by only 3 percent causing congestion to rise by 126 percent.

4. Texas currently funds normal transportation spending [excluding the Texas Mobility Fund] primarily through the following:

    a. The state motor fuel tax - 20 cents per gallon (15 cents goes to transportation and 5 cents to public education).

    b. The federal motor fuel tax - 18.4 cents per gallon.

    c. Motor vehicle registration fees.

5. Maintenance and rehab of the existing system consumes approximately 85 percent of normal TxDOT spending [excluding the Mobility Fund], leaving less than $750 million per year from normal spending for all new capacity lanes to be constructed throughout the state. Inflating maintenance, rehab, and new capacity costs could eliminate all normal funding currently available for new capacity lanes within 5 years.

6. Limiting transportation expansion to the Metropolitan Transportation Plans (MTP) over the next 25 years will create a statewide average Texas Congestion Index (TCI) of 1.48, a 98 percent increase in congestion over today's average TCI of 1.25. The Texas Metropolitan Mobility Plan (TMMP)[1] targets a 1.18 TCI, a decrease in congestion by almost 40 percent compared to current levels and 167 percent from anticipated congestion under the MTP.

[1] The MTP scenario includes costs for planned reconstruction. The TMMP scenario includes no additional rehabilitation costs beyond what is included in the MTP.

7. To achieve the TMMP target of a 1.18 TCI value over the next 25 years requires an additional $66 billion in state and local roadway expenditures over revenue sources currently identified in the MTP using today's dollars.

    a. Based on historical funding trends, approximately two-thirds of this shortfall, or $44 billion, would need to be funded by the state, and the balance would be funded locally. Federal transportation reauthorization passed after the MTP were completed could reduce TxDOT's portion of the shortfall to $32 billion.

    b. The federal and state fuel taxes represent the bulk of transportation funding, are fixed amounts per gallon, and lose real value over time with inflation. Revenue streams must increase with inflation to keep the state's estimated portion of the shortfall at $44 billion in today's dollars.

    c. The $44 billion shortfall can be funded in multiple ways. These include indexing in conjunction with the Texas Mobility Fund, financing, toll roads, stopping the diversion of transportation dollars, or an increase in the state motor fuel tax. If state and federal fuel taxes are adjusted by the Highway Cost Index, the entire metropolitan shortfall can be funded with an eight cent per gallon fuel tax increase. If no indexing occurs, the fuel tax must be increased by 31 cents per gallon.

8. A $66 billion investment by state and local governments in transportation infrastructure improvements over the next 25 years makes good economic sense. It reduces congestion by 40 percent from current levels, 167 percent from future anticipated levels under the MTP and generates $541 billion in economic benefits (an 8.2 to 1 benefit cost ratio) broken down as follows:

    a. $37 billion in fuel cost savings to consumers due to less congestion

    b. $104 billion in travel time savings

    c. $78 billion in economic efficiencies to business and their resulting economic impact

    d. $322 billion in economic impact of construction

    The $44 billion TxDOT shortfall is almost entirely offset by the $37 billion in fuel cost savings to consumers alone.

9. Transportation improvements are needed to maintain the competitiveness of the Texas metropolitan regions. Among the aspects of competitiveness discussed in this report are the importance of both landscape and housing affordability.

a. Landscape - Aesthetics are relatively inexpensive to add compared to the cost of roadway construction. Improving the look of roadways and roadside makes it easier for employers to attract and retain employees to the urban areas. It also softens the look of the new capacity lanes that are required to handle the state's growing population.

b. Housing – The state and regional unrestrictive growth plans, policies, and investments in transportation have resulted in the least expensive housing in the U.S. and lower congestion levels than comparable size metropolitan regions giving Texas an enormous economic advantage over other states. Mobility and housing affordability will continue to be related to one another and are critically important components of Texas' economic welfare.

10. Increased commerce from NAFTA impacts Texas more than other states. Truck traffic crossing the Mexico – Texas border between 1996 and 2002 increased at a rate of 26 percent compared to an overall traffic increase of 10 percent. This trend is expected to continue or increase.

11. Accelerating transportation improvements through borrowing makes good economic sense. The examples used in this report generate $16 billion in benefits while the $1.28 billion in additional interest cost is nearly offset in its entirety by the avoidance of $1.24 billion in construction cost inflation.

RECOMMENDATIONS

1. Fund TxDOT's $44 billion shortfall for state roadway improvements necessary to cut future congestion in the areas of the report by 167 percent, 40 percent less than current congestion levels, and achieve a 1.18 TCI congestion goal set forth in the TMMP. This shortfall should be paid for by some or all of the following:

    a. To protect the purchasing power of the state and federal motor fuel tax, we must insure that the value of the two taxes is not eroded by inflation by indexing the rate to keep pace with inflation. This would insulate approximately 85 percent of TxDOT's revenues from losing value to inflation.

    b. Additional revenue generated from indexing should be placed in the Texas Mobility Fund or a similar entity. The bond debt to accelerate the state's portion of the entire construction shortfall could be borrowed and repaid solely from proceeds of the fuel tax indexing revenue increment.

    c. The use of toll roads where possible subject to the following:

        1) All tolls, franchise fees, or any other charges or benefits derived by TxDOT or local toll authorities from within a region should be required to be reinvested in transportation or mobility projects within the same area.

        2) A regions' construction and expansion of toll roads should in no way reduce or otherwise penalize the area for receiving its fare share funding allocations from TxDOT.

        3) Utilize local toll authorities when possible in an effort to maximize cooperation and coordination between TxDOT and local transportation systems.

    d. Regarding long term planning, aggressively borrow money to build improvements since interest expense alone is roughly equal to the cost of inflation of road construction and enormous additional savings are derived from accelerated completion. Regarding short term planning, aggressively expand the use of financing to accelerate the expansion of critically congested sections of the state highway system. Financing would allow select critical projects to be undertaken sooner and completed more quickly often with significant benefit to cost ratios.

    e. Stopping and reversing the practice of diverting transportation taxes and other state funds intended for the maintenance, design, and construction of roads to non-transportation uses.

f. To the extent that these or other methods (indexing in conjunction with the Texas Mobility Fund, financing, toll roads, stopping diversions,) are not sufficient to pay for this shortfall, allow the metropolitan areas to pass a local fuel tax or increase the state motor fuel tax. If state and federal fuel taxes are adjusted by the Highway Cost Index, the entire metropolitan shortfall can be funded with an eight cent per gallon fuel tax increase. If no indexing occurs, the fuel tax must be increased by 31 cents per gallon. Any local fuel tax increase should in no way reduce or otherwise penalize the area in receiving its fare share funding allocations from TxDOT.

2. It is increasingly difficult in the urban areas to improve mobility on the TxDOT system without working on and expanding local streets. The relief of congestion on the TxDOT system can be enhanced by widening, improving, and constructing local roads that will provide congestion relief for the TxDOT system. Consideration should be given to authorizing TxDOT to expand its use of funds "off the system" to relieve congestion "on the system." The state should also give major urban areas maximum legislative flexibility to generate local revenue in addition to toll options, subject to a vote of the citizens being affected, to pay for the local road expansion necessary to achieve the TMMP goals. The state's major urban areas disproportionately attract business and create jobs, and, to continue to do so, must have the ability to solve their transportation challenges as each region deems best.

3. Continue the strategic planning process and annual monitoring of the progress in achieving the 1.18 TCI, including tracking revenue, cost of construction, and other components of the TMMP. Commit to increasing transparency of all TxDOT data, including revenues and expenditures.

4. Continue to allow the free market to dictate the growth of our regions as well as continue our existing land use and transportation policies that have contributed to Texas urban areas having the lowest cost housing of any large cities in the nation.

5. Continue our commitment to highway beautification as a standard part of roadway improvement and expansion programs to improve our overall quality of life.

EXECUTIVE SUMMARY

Introduction

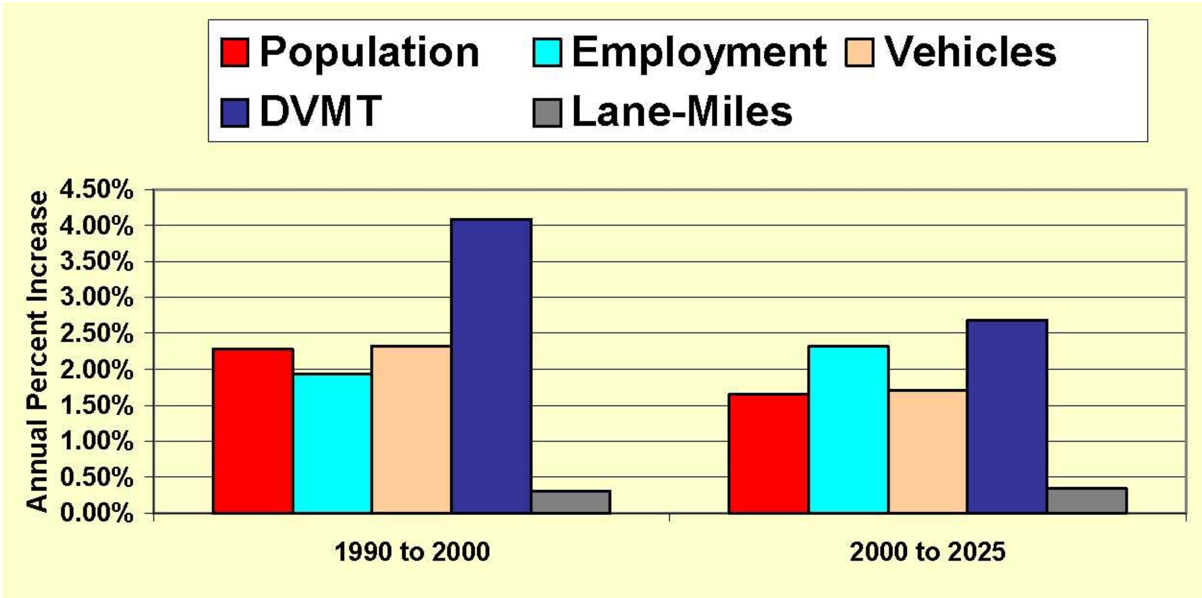
The future of Texas is tied to the economic health of its metropolitan regions. Texas has flourished because of several aspects of policy and development practices. One of the outcomes of the past is that transportation is a vital part of Texas' future. Traffic congestion threatens this future and is projected to increase in every metropolitan region with the currently expected funding. This report investigates what can be done to improve mobility in the next two decades and the important accompanying elements of that improvement.

The problems we face are a product of growth and affluence and the result of Texas' approach to development. Our economy is healthy and more growth is expected in the future. With this growth come challenges. As we move into a new era of labor force change in which the nation's labor force is aging, a new set of factors will serve to guide economic development. One of these will be the need to attract skilled workers. In many cases these workers will be working in fields, such high technology and services, where they can be almost anywhere. Quality of life issues – mobility, beautification, housing affordability, school quality and transportation – will be the keys to successfully competing for and retaining this future work force.

Improving Mobility

Texas is an urban state. Seventy percent of the current population lives in the eight largest metropolitan regions, and 90 percent of the growth in the next two decades will occur there.

Vehicle travel has grown much faster than population in the past two decades. This is expected to be more equal in the next two decades. Economic growth will happen, but it will be easier to address. Current trends point to a closer match between the growth in vehicle travel and lane-miles which should help minimize the increase in congestion.



Changes made to transportation finance over the last two state Legislative sessions and the resulting improvements in planning processes mean that future congestion levels are not expected to be as bad as projections of just a few years ago. But more needs to be done.

The report estimates that over the next 25 years for the metropolitan areas it will require $66 billion in roadway expenditures over the $120 billion available from currently identified sources to achieve the Texas Metropolitan Mobility Plan (TMMP) target of a 1.18 TCI value. For the purposes of this report, it is estimated that approximately two-thirds of the $66 billion of this shortfall would be state funds and one-third of the funds required to meet the mobility goals would come from local/other sources. This assumption is based on existing state-local funding share arrangements. Under this assumption, the total cost to the state to achieve the TMMP mobility goals is estimated to be $44 billion over 25 years, less than the $78 billion in TxDOT needs estimated in the first Governor's Business Council report in 2003. There are several reasons for the reduction:

- The TMMP's Texas Congestion Index (TCI) target of 1.18 is slightly higher than the 1.15 established in the 2003 Governor's Business Council Report. The higher target value requires less funding. A more detailed assessment of the congestion problem in each of the eight largest metropolitan regions developed a mobility target for each area that cost effectively addresses that region's problem. The TCI measures the extra travel time in the peak period compared to the travel time in free-flow conditions (a TCI of 1.30 indicates a 20-minute midday trip will take 26 minutes in the peak).

- The statewide planning process, initiated by Governor Perry and being carried out by TxDOT and the Metropolitan Planning Organizations (MPOs) using a needs-based approach with a mobility goal, appears to have resulted in a more effective planning process that will lead to more focused road construction that will further lead to lower expenditures to attain the same congestion targets.

- The recent round of Metropolitan Transportation Plans (MTP) updates includes more toll roads which reduce congestion more than was projected.

- A more detailed analysis was used in this report to estimate the TCI values. Much more detail, available from the improved planning process, allows for a more accurate roadway needs estimate. The new process focuses on providing additional capacity to congested road segments rather than a generalized process of adding enough roadway to address average congestion problems.

Reconciliation with TxDOT Predicted Shortfall

TxDOT's estimated statewide construction shortfall of $86 billion is made up of $68 billion in the metropolitan areas (as compared to the $66.2 billion estimate produced by the GBC), $9 billion in "other" urban areas, and $9 billion in rural areas of the state. Historically one-third of metropolitan area shortfalls are funded locally (one-third of $66 billion reduces the total state requirement by $22 billion). Furthermore, the preliminary estimates from the Texas Urban Mobility Plan, to be published soon, are likely to identify $2 to $3 billion in "other" urban area need, as opposed to the $9 billion originally estimated by TxDOT. (This reduces the total state requirement by another $6 billion.) The result is a $56 to $58 billion dollar state funding shortfall (we have used $56 billion for the purposes of this report) to reduce congestion by 40 percent while adding up to 14 million people to the state's population, an incredible achievement.

In sum then, when comparing like areas, the difference between the GBC estimate and the TxDOT estimate for the eight largest urban areas of the state is $1.8 billion, or less than three percent ($66.2 billion versus $68 billion). While this report focuses primarily on the eight urban areas covered in the Texas Metropolitan Mobility Plan, the additional $12 billion in estimated additional need in other urban areas and in rural Texas is also addressed in brief.

How to Fund the Shortfall

Reducing the $44 billion metropolitan area state funding shortfall can be accomplished in a variety of ways.

The motor fuel tax continually loses value to inflation over time because it is assessed on a gallon of fuel rather than on the price of fuel. Today, because of inflation, the 20 cent per gallon fuel tax enacted in 1991 is now worth approximately 14 cents (see Section 1 of report). One solution to this problem is to increase the state fuel tax annually by an amount equal to a measure like the Highway Cost Index (HCI) multiplied by the state and federal fuel taxes in order to keep pace with the cost of constructing and maintaining roadways. This would protect purchasing power, insulating approximately 85 percent of TxDOT's revenues from losing value to inflation.

A possible solution to the metropolitan area $44 billion state funding shortfall would be to place the additional revenue generated from the indexing process described above into the Texas Mobility Fund, or a similar vehicle that would allow borrowing against that revenue stream. If the 20 cent per gallon fuel tax rate was not raised but simply adjusted in the future by a rate equal to 80 percent of the Highway Cost Index (HCI), the projected 2.7 percent annual increase would be sufficient to borrow the estimated $44 billion shortfall. To address the possible need for the entire state system, including rural and urban areas, of as much as $56 billion, the tax rate would need to be adjusted annually by 90 percent of the HCI, or 3.1 percent. Furthermore, in both scenarios, the bond debt could be serviced entirely with the proceeds from the incremental fuel tax increase.

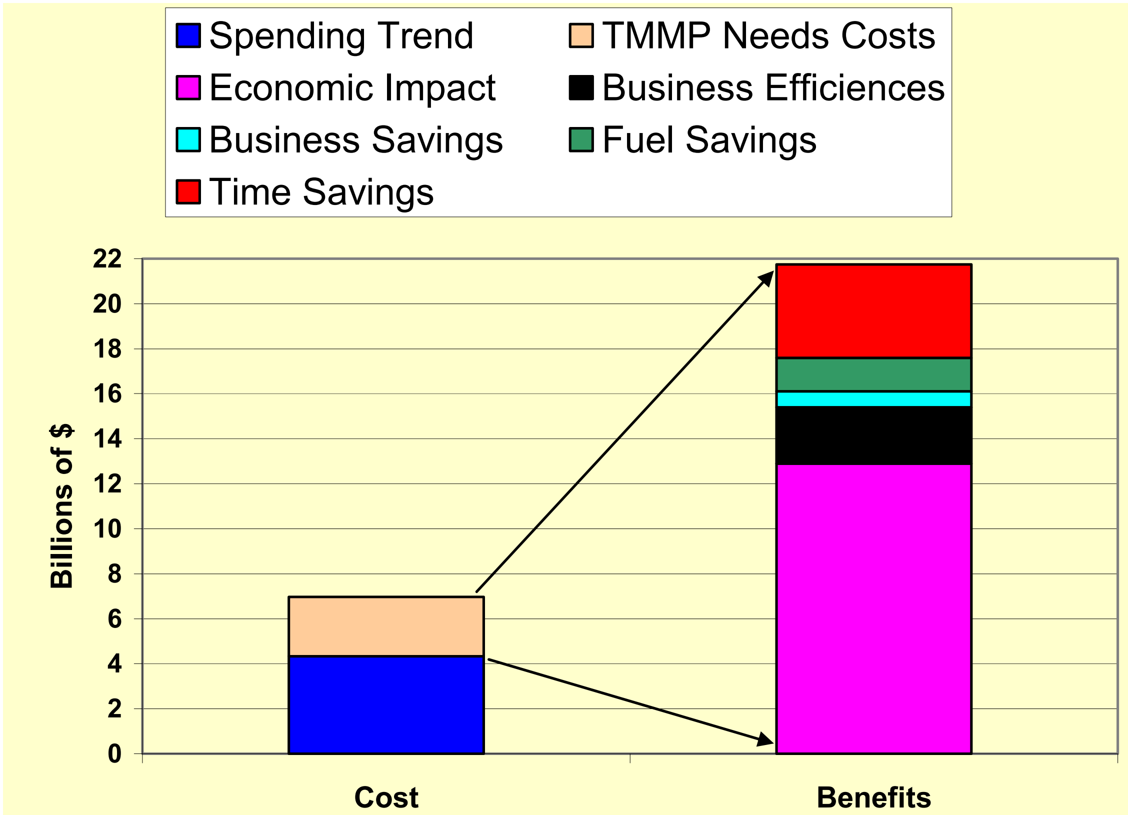
Additional potential solutions to the $44 billion metropolitan area state funding shortfall include the use of toll roads where possible and stopping the diversion of state transportation revenues into non transportation related purposes. The use of toll roads allows the construction of critical projects to be made possible in the absence of traditional transportation funding sources, and stopping diversions allows valuable transportation dollars to be spent on transportation projects.

Finally, the statewide funding shortfall including urban and rural areas could be achieved by an increase in the state motor fuel tax. For example, if the state motor fuel tax was indexed by an amount equal to the amount of increase in the highway construction index on both the state and federal motor fuel tax, the initial fuel tax increase necessary to achieve the $44 billion metropolitan area state funding shortfall would be 8 cents. To achieve the statewide $56 billion shortfall, the initial fuel tax increase necessary would be 12 cents (see Section I of report for further discussion).

Benefits of Reducing Congestion

The benefits to achieving the above stated mobility targets are substantial. For the $66 billion additional state and local investment in our transportation system we receive over $541 billion in total benefits. These include more than $37 billion in fuel cost savings in addition to an estimated travel time savings of almost $104 billion. Business efficiencies and business operating savings due to reduced congestion are estimated at almost $78 billion. The effect of the construction activity is projected to add approximately $322 billion to these benefits. Put another way, as a result of the expenditure of an additional $2.65 billion annually, $21.7 billion in annual benefits are realized through savings and additional economic activity.

Annual Costs versus Benefits of Implementing TMMP Needs-Based Plan



There are some risk factors, however, associated with the estimate of available funding. As an example, it is not clear at this point what the effect of significantly higher fuel prices will be on travel patterns and subsequent fuel consumption. It is possible that any reduction in travel demand will also reduce the amount of funding required for highway system capacity additions.

Benefits of Accelerating the Construction of Road Improvements Using Financing

The investment needs identified in Section I are a combination of the current deficiencies of the existing system with those investment needs that will be generated over time from future population and economic activity growth. Were the present system perfect in performance and condition, meeting future needs over time would be a relatively straight-forward undertaking. It is not, and the benefits from accelerating the response to the extensive state and local backlog of needs are substantial.

While the full-scale backlog of investment requirements in highways should be identified, the present congestion levels throughout the state shown in Section I are an implicit indicator of the massive backlog of system performance needs. On the condition side there were 2,580 bridges in the state identified as of 2004 as Structurally Deficient and another 7,615 identified as Functionally Obsolete. Thus a total of 10,195 bridges, more than 20 percent of the state's bridges, were labeled as deficient out of a total of fewer than 50,000 bridges in the state. While this is better than many other states, it is a strong indicator of a critical backlog in terms of safety and performance.

Addressing the backlog by shifting to an accelerated program in which projects are started sooner and constructed more rapidly have immense payoffs:

- the benefits of the project in safety and performance are provided sooner
- cost growth effects of inflation are reduced (roughly equal to additional interest expense on bonds sold to pay for improvements)
- other beneficial projects can be brought forward into the project stream
- there are often logistical benefits to contractors working faster in larger undertakings

Other states have recognized these payoffs and are acting to accelerate their programs, often cutting delivery times to one-third of traditional approaches, with a combination of re-organized programming of projects, bonding, toll-oriented systems, and joint private-public efforts. The early benefits of this approach for Texas are substantial.

The report documents the benefits from mobility improvements in each region – the "what gets done" benefit. Another essential aspect of this improvement is the "how it gets done" benefit. There are enormous benefits to building the improvements faster and closer to when they are needed rather than waiting for funding streams to provide the needed infrastructure. The report investigates some of the issues related to financing the needed improvements and suggests additional study to dramatically speed system expansions.

- Expanding roads now provides significant mobility improvements resulting in travel time and fuel consumption savings to residents and commuters. The fuel savings from mobility improvements alone, assuming $2.80 per gallon gasoline, represents $37 billion in out-of-pocket cost savings.
- If an approach that recognizes the importance of rapidly improving the road network were used, the cost of borrowing construction funds would be approximately offset by the inflation in construction costs.
- The cost of borrowing to finance improvement is roughly equal to the inflation cost associated with deferring construction. Therefore, the cash outlays to the state over 25 years are approximately the same. To accelerate $36 billion in major projects in congested corridors costs $1.28 billion in additional interest, but saves $1.24 billion in inflated construction costs and provides benefits exceeding $16 billion. The society benefits include $2.2 billion in out-of-pocket fuel savings due to congestion reduction.

Beautification Programs

The Texas Department of Transportation has an extensive program of planning roadway aesthetic improvement. These plans include structures, the roadside and plantings in a combined set of treatments that are both visually pleasing and easily maintained. Aesthetic treatments are recognized as important factors in the perception and acceptance of major roadway improvements, and in many metropolitan regions these improvements appear to be a significant feature of public input, public discussion and acceptance of a major construction program. Many aesthetic treatments are considered a normal component of a roadway project and are included in most new construction projects. Their relative cost, in these cases, is quite low and typically included in new capacity or major reconstruction projects.

The most frequent generator of favorable and unfavorable responses, however, was the area outside of the right-of-way. Addressing the quality and look of adjacent developments will take time, but providing maintenance and litter control are relatively less complex activities that have significant benefits in improving the visual landscape.

The landscape portion of this effort has resulted in a broadly similar practice on TxDOT construction efforts. “Naturalized plantings” that replicate native plant communities are installed within the right-of-way at the conclusion of construction activity. Local agencies or groups are responsible for maintaining any of the ornamental or special landscaping elements.

Natural plantings and aesthetic roadway designs

Emissions

Over the next 25 years, 88 percent of existing emissions will be eliminated due to improvements in emissions control technology, fuel mixtures and vehicle operating systems regardless of the amount of congestion. If congestion is reduced, emissions will decline further while accommodating all projected travel increases due to population and employment growth.

- Total emissions are an average of 80 percent lower than current amounts despite travel increasing between 50 and 175 percent in the metropolitan regions.

- Emissions per million vehicle miles are forecast to be approximately 88 percent lower than current rates.

Competitiveness and Traffic Congestion

Nearly all growth in the United States has been in metropolitan regions since World War II. Metropolitan regions have grown because they are efficient labor markets that provide economic opportunities that are generally more favorable than in other areas. One of the keys to Texas competitiveness has been the fact that its urban areas have generally lower levels of traffic congestion than other urban areas of similar size. Implementation of the Texas Metropolitan Mobility Plan Mobility Objectives is likely to improve mobility in Texas metropolitan regions even further, widening the gap with other areas throughout the nation.

Texas metropolitan regions are very competitive. Dallas-Fort Worth and Houston are the third and fourth fastest growing large urban areas in the high-income world (Atlanta is number one). Research indicates that metropolitan regions have greater economic output if they are more mobile. The critical issue is the number of jobs that can be accessed by employees in a particular period of time (such as 30 minutes).

Densification (land rationing) policies are sometimes suggested as a means for reducing traffic congestion. In fact, densification increases traffic congestion. Travel speeds become more erratic, which leads to more intense air pollution emissions.

Competitiveness and Housing

Texas metropolitan regions have among the best housing affordability in the nation. The lower cost of living in Texas contributes to the state's competitiveness. In 1999, Dallas-Fort Worth and Houston had the most affordable housing among urban areas with more than 3 million persons. There are indications that this advantage has been expanded in the last five years.

The latest data indicate that if housing affordability in Dallas-Fort Worth were at Boston levels, median household income would need to be $10,700 higher to support the higher annual mortgage payments. That same house in San Francisco would require a median household income $20,700 higher than current Dallas-Fort Worth levels.

Denser land development patterns and restrictive growth policies are associated with artificially higher housing values. Metropolitan regions with land rationing have approximately 50 percent higher affordability multiples than areas without such policies. More recent research associates more stringent land use regulation with less than expected economic growth.

Texas metropolitan regions have not severely restricted the growth patterns, and, as a consequence, the cost of development is relatively low, allowing decisions to be made to build on the most economically viable parcels. This process is supported by the transportation investments that have been made over the past several decades. The superior mobility levels in most metropolitan regions provide a wider range of housing and job location choices than similarly-sized regions. Present Texas land use and transportation policies should be continued, which will maintain and improve the state's competitiveness, while providing housing opportunity and a better quality of life for a diverse population.

Freight

Trucks carry 60 percent of freight in Texas. National projections indicate that truck traffic is increasing at a faster rate than that of cars and sport-utility-vehicles. The faster truck growth rate makes it more challenging to provide sufficient new roadway space to control traffic congestion.

Large trucks use 3.8 times more highway space than cars and sport-utility-vehicles on an urban freeway. In recent years, the safety record of trucks has been substantially improved, although there are still more than 400 fatal accidents that involve trucks in Texas. It is important that efforts be continued to improve truck safety. One of the most effective means for improving truck and other vehicle safety is to provide sufficient roadway capacity.

Texas is impacted by NAFTA commerce increases more than any other state. There have been substantial increases in truck traffic at border crossings between Texas and Mexico. There is a need for more information on truck traffic in Texas. TxDOT and the MPOs should undertake efforts to estimate truck volumes within metropolitan regions and on major freeway segments on an annual basis.

Various strategies can be used to better facilitate truck traffic. For example, truck only lanes and roads can be built. There may also be opportunities for targeted improvement, such as intermodal projects to improve both truck and rail freight movement at ports (such as what has been implemented in Los Angeles and is being evaluated in Houston).

SECTION I
Improving Mobility: How Much Does It Cost and What Do We Get?

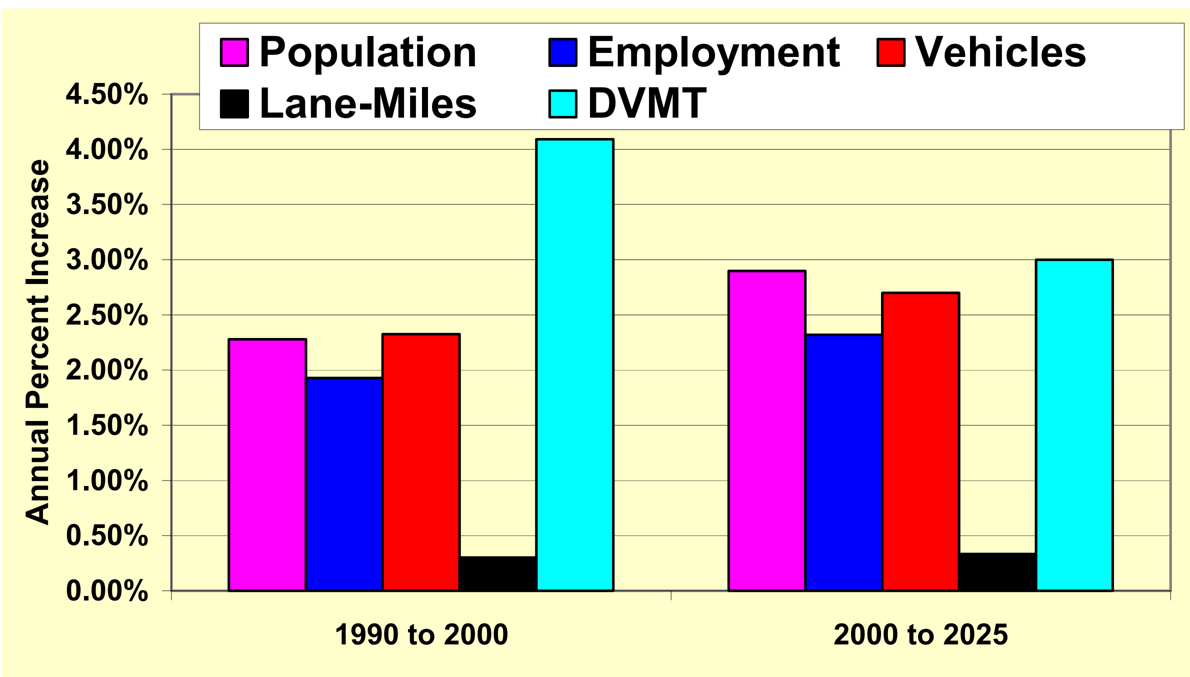
Background

The Governor's Business Council Plan

In early 2003, the Governor's Business Council (GBC) completed a unique analysis of Texas's future metropolitan roadway needs. The purpose of the Governor's Business Council study (GBC-1) was to establish a process where vision, needs and accountability drove the process of transportation improvement, as opposed to having available funds dictate the amount of transportation improvement projects and programs. In other words, the GBC approach sought to address "how we can fulfill our mobility vision" rather than simply "what does the funding allow."

The need for this change in focus, as shown in Exhibit 1, was driven by the fact that our state's population, employment and the daily vehicle-miles traveled (DVMT) have increased (and are projected to continue to increase) at rates significantly faster than our increase in lane-miles of roadway.

Exhibit 1: Change in Key Indicators of Transportation Demand and Supply



Additionally, the growth in population, employment, vehicles, and DVMT is not even across the state. While the state's population is expected to increase from 20.9 million in 2000 to as much as 36 million in 2025, nearly 90 percent of this increase will occur in the state's largest metropolitan areas. Furthermore, employment, which generates more trips during the already-congested peak-periods, is expected to increase faster than population. This focus on a defined vision and needs represents an important addition to current practice, from a financially constrained process to one based upon defining minimum performance standards and then identifying and securing the resources to accomplish the objectives.

More specifically, the study sought to answer the following major questions:

1. In order to ensure adequate transportation performance, how much capacity, in what metropolitan areas must be added in order to achieve certain mobility goals? Roadway lane-miles were used as a way to estimate the capacity and cost of the programs, projects, policies and partnerships that will be required to address the congestion problems. The study did not suggest that lane-miles of roadway were the only way to solve the problem, only that they were the easiest method to estimate the size of the problem. If built, however, they would achieve the target mobility levels.

2. What will it cost to achieve these goals?

3. What is the economic return on the alternative investment levels made by the state to achieve these mobility goals?

The Texas Metropolitan Mobility Plan

Perhaps the big story from the Governor's Business Council's first report was that the effort produced results in that it helped change the planning focus from spending available revenue to reducing congestion levels. For example, as a result of the GBC study, Governor Rick Perry instructed the Texas Department of Transportation (TxDOT) to develop a plan to improve mobility and reduce congestion in metropolitan Texas. His letter of March 2003 challenged TxDOT to better meet the needs of metropolitan Texas.

Additionally, the Governor's Business Council showed that congestion cost Texans more than $45 billion in delay and wasted fuel during the 1990s. The report also showed that an additional $78 billion investment in transportation over the next 25 years to reduce metropolitan congestion could produce a benefit of more than $500 billion in the next 25 years with an estimated benefit-to-cost ratio of more than 6.5:1.

Responding to the Governor and building on *Transportation Partnerships*, the leadership of TxDOT formed a core team of TxDOT, Federal Highway Administration (FHWA) personnel and leaders of the metropolitan planning organizations (MPOs) to develop an approach to better meet the needs of metropolitan Texas and to reduce congestion. Through 2003 and 2004, that core team discussed issues, identified challenges and developed a strategic approach. From that effort, the *Texas Metropolitan Mobility Plan: Breaking the Gridlock* (TMMP) was produced.

Objectives of This Study

Following the TMMP report, this study (GBC-2) was undertaken to help move the state forward toward further assessing the costs and quantifying the impacts of major mobility improvements. To that end, the objectives of this part of the study are as follows:

1. Reconcile the 25-year cost estimates contained in the Governor's Business Council Plan to the cost estimates prepared as a part of the Texas Metropolitan Mobility Plan.

2. Include both state roads and major city streets in this study for calculating congestion targets. (The GBC-1 study included only state maintained roadways.)

3. Reconcile estimates of emission reductions and the benefits done for the original Governor's Business Council Study to the estimates contained in the Texas Metropolitan Mobility Plan.

4. Estimate the amount of state funds available for actual construction, rehabilitation and maintenance.

5. Perform an analysis of constructing the entire "needs based" system over a much shorter time period with financing versus using a pay-as-you-go system.

6. Assess the costs of beautifying the highway system as well as acquiring extra right of way to construct additional landscaping. Compare this cost to the total project costs and evaluate the benefits.

Differences in the GBC and TMMP Approaches

There are several key differences between the GBC-1 and TMMP studies that require explanation.

First, the GBC-1 report defines mobility goals in terms of the Travel Time Index (TTI) while the TMMP study does so in terms of the Texas Congestion Index (TCI). Although they are essentially the same in terms of what they measure, the measurement values cover different geographies and use different data sets and analysis procedures and hence show slightly different initial and terminal values.

The Travel Time Index (TTI), used by the Texas Transportation Institute in their annual Urban Mobility Report, is an urban area-wide mobility measure. Simply put, the index is the ratio of peak period travel time to free-flow travel time. The Travel Time Index expresses the average amount of extra time it takes to travel in the peak period relative to free-flow travel. A Travel Time Index of 1.30, for example, indicates that a 20-minute off-peak trip will take 26 minutes during the peak travel periods (20 x 1.30 = 26).

The Texas Congestion Index is the same type of peak-to-free-flow travel time ratio. Long-range transportation planning model outputs are used in the calculation. Like the TTI measure, these volumes have transit riders removed from the highway demand, so the analysis includes the effect of transit in the congestion levels. Travel speed is estimated for every link of the road system, and delay is calculated using the difference between the hourly speed estimate and the free-flow speed on each link. A factor is used to estimate the delay increasing effects of collisions and vehicle breakdowns. A spreadsheet process is used with these numbers to estimate the improvements due to a variety of operational treatments. The first generation numbers include freeway incident management and ramp metering and arterial street signal coordination and access management. Additional treatments are being added for subsequent years. Finally, the data are summarized by road type and area type within each metro region, rather than only for the urbanized area.

The Texas Congestion Index has been adopted by both TxDOT and the various MPOs as the standard measure for metropolitan area mobility and, as a result, it is recommended that from this point forward the GBC use this methodology and terminology in discussions and calculations of urban mobility. (See Appendix for a schematic diagram illustrating the Texas Congestion Index calculation process.)

In essence, the TTI and the TCI are analogous in the way they measure congestion, i.e., using an index with 1.00 representing free-flow conditions and the TTI or TCI value above 1.00 representing the percent of extra travel time.

As noted previously, the second major difference between the two studies is in terms of their geographical area. The GBC-1 study focused on urban areas within the Houston, Dallas-Ft. Worth, Austin, and San Antonio urban areas plus the "Border" region that included the Lower Rio Grande Valley, Laredo, and El Paso urban areas.

The TMMP study includes the Houston, Dallas-Ft. Worth, Austin, San Antonio, Hidalgo County, El Paso, Corpus Christi, and Lubbock metropolitan regions (these are not necessarily the official Census Metropolitan Statistical Areas). In general, metropolitan regions include the rural portions of counties as well as what is included in the "urban area" geography that comprises the Travel Time Index calculation. As a result, and as shown in the following table, TCI values tend to be somewhat lower than TTI values for similar areas.

Exhibit 2: Comparison of Current TCI and TTI Values

	2000	
Area	Current TCI	Current TTI
Austin	1.22	1.26
Corpus Christi	1.05	1.04
Dallas	1.30	1.31
El Paso	1.15	1.16
Hidalgo	1.04	1.05
Houston	1.34	1.36
Lubbock	1.02	1.04
San Antonio	1.21	1.24

In the first GBC study, the counties contained in the study represented 68 percent of the state's population and 57 percent of the state's daily vehicle miles traveled (DVMT). All other counties, whether urban or rural, were grouped into the "Balance of State" category. In this study, the metropolitan areas included represent 71 percent of the state's population and 62 percent of the DVMT.

A comparison of the study areas is shown on the following page.

Exhibit 3: Comparison of Counties Included in GBC and TMMP Study Areas

Analysis Region	County	Analysis Region	County
Austin	Hays	Austin	Hays
	Travis		Travis
	Williamson		Williamson
Dallas-Ft. Worth	Collin	Dallas-Ft. Worth	Collin
	Dallas		Dallas
	Denton		Denton
	Ellis		Ellis
	Johnson		Johnson
	Kaufman		Kaufman
	Parker		Parker
	Rockwall		Rockwall
	Tarrant		Tarrant
Houston	Brazoria	Houston	Brazoria
	Ft. Bend		Ft. Bend
	Galveston		Galveston
	Harris		Harris
	Liberty		Liberty
	Montgomery		Montgomery
	Waller		Waller
San Antonio	Bexar	San Antonio	Bexar
	Comal		Comal
	Guadalupe		Guadalupe
Border	El Paso	El Paso	El Paso
	Hidalgo	Hidalgo	Hidalgo
	Cameron		
	Webb		
		Corpus Christi	Nueces
			San Patricio
		Lubbock	Lubbock

The third major difference between the two reports is that the GBC-1 report included only state roads that are classified as principal arterials and freeways and accounted for a total of 38,545 lane-miles in the urban areas included in the study. The TMMP report includes all roads, both local and state-owned, that are classified as minor arterials, principal arterials and freeways and represents a total of 55,800 lane miles.

The fourth major difference between the GBC-1 analysis and the TMMP is that the GBC-1 used four different mobility scenarios, as measured by the TTI, for all urban areas included in the study. Those scenarios were tied to specific TTI targets of 1.25, 1.20, 1.15, and maintaining the existing TTI for the area. In contrast, the TMMP plan used the same goal for all areas – eliminate all of the serious congestion problems on the system. Such an approach produced slightly different TCI goals for each of the metropolitan areas as follows:

- No-Build – Future year volumes (either 2025 or 2030 depending on the available transportation planning models) on the base year roadway network. This was used for comparison purposes only.

- Metropolitan Transportation Plan (MTP) – The federally-mandated financially constrained plan for the region based on known sources of revenues.

- TMMP Needs-Based Plan – A system that eliminates all locations of serious congestion. (In the Needs-Based Plan "serious congestion" is defined as being those areas where daily volume exceeds daily capacity.)

Focusing on only the problem locations resulted in a different areawide average TCI for each region because the remaining road systems have different levels of light congestion. So, while the same goal was used, the "Needs" scenario has a different numeric indicator. The following table shows the estimated TCI values for the base year and for the MTP and Needs scenarios for each metropolitan area in the terminal year of the plan.

Exhibit 4: Texas Congestion Index (TCI) Values for TMMP Scenarios

Area	TMMP Model Area Base Year TCI	No Build Scenario	MTP Terminal Year TCI	TMMP needs-based Plan Terminal Year TCI
Austin	1.22	2.14	1.44	1.14
Corpus Christi	1.05	1.79	1.61	1.13
Dallas-Ft. Worth	1.30	3.21	1.53	1.20
El Paso	1.15	2.37	1.34	1.06
Hidalgo	1.04	1.71	1.23	1.08
Houston	1.34	3.00	1.48	1.21
Lubbock	1.02	1.25	1.17	1.09
San Antonio	1.21	2.03	1.47	1.12
Statewide Average	**1.25**	**2.31**	**1.48**	**1.18**

The two Governor's Business Council reports also differ in their estimates of the cost to reduce congestion. While the goal of both reports was the same, there are several improvements in the GBC-2 analysis and datasets. These are the result of both improved procedures and the efforts of the joint working group of TxDOT and Metropolitan Planning Organization staff. The major factors in the improvements are summarized below.

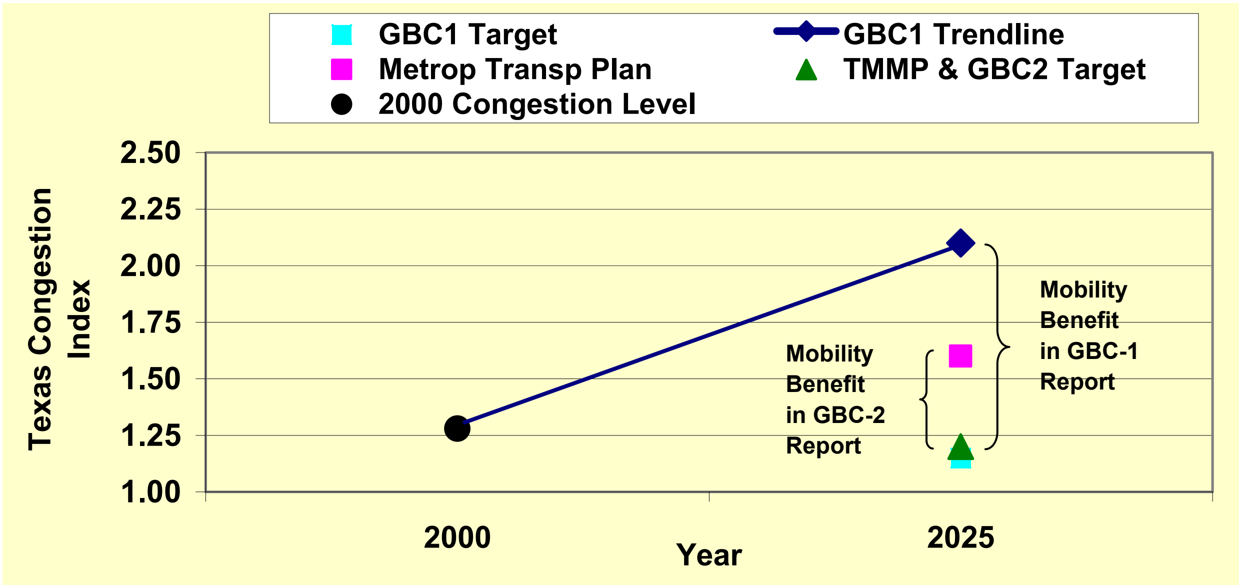
- Use of regional transportation planning models: Detailed, long-range computer models were used in the Texas Metropolitan Mobility Plan process rather than the relatively aggregate statistics used in the GBC-1 report. The computer models begin with estimates of population, employment and transportation networks. The models develop detailed traffic estimates that can be used for congestion forecasts. *The planning models provide more detailed estimates of travel demand and congestion.*

- Roadway growth estimates: The GBC-1 report used the trend in road construction during the decade before 2000 as a basis for the road growth projections. *Transportation financing options passed in recent Texas Legislative sessions have increased the rate of road expansion* expected in the 2005 to 2025 period as shown in the Metropolitan Transportation Plans in the eight study regions.

- Congestion target level differences: The *Texas Metropolitan Mobility Plan* approach identified the congested sections of road and estimated the amount of capacity needed to meet the congestion target, only treating the significantly congested sections of road. Detailed long-range planning models were used in this calculation. The GBC-1 report estimated the amount of capacity needed to reduce the area-wide average congestion level below the goal levels by adding roadway to the total system. *The TMMP analysis focuses congestion relief estimates on the congested sections of the network.*

- Cumulative effect of differences on congestion estimates: The lower estimates of road growth in the GBC-1 report, the use of the Metropolitan Transportation Plans, and the differences in the additional roadway calculations are illustrated in Exhibit 5. The change from using the 1990 to 2000 trend to using the results of the Metropolitan Transportation Plans significantly reduces the "baseline" congestion levels because more areas with less congestion are included in the analysis, which, in turn, reduced the benefits of congestion relief. The difference in congestion targets is less significant but the overall effect is to increase the congestion levels in the "goal" condition for the Texas Metropolitan Mobility Plan (used in this report). *Narrowing the gap between expected congestion and the target reduced the delay and fuel consumption benefits from the congestion relief programs.*

Exhibit 5: Congestion Trend Differences between GBC-1 and GBC-2 Studies



The Results

Exhibits 6A and 6B show the base year and terminal year TCI for the various metropolitan areas as a result of implementation of the TMMP Needs plan. Note that the future congestion levels in three of the eight regions are slightly higher than the base year estimates. In these instances, all of the serious congestion problems in these areas have been addressed, but light congestion on more of the system in future years will mean that the areawide congestion average is slightly higher than current conditions. The five largest metropolitan areas all show substantial reductions in congestion over both current and MTP Plan levels.

Exhibit 6A: Estimated Change in Texas Congestion Index Value during TMMP Needs Plan Implementation (Large Cities)

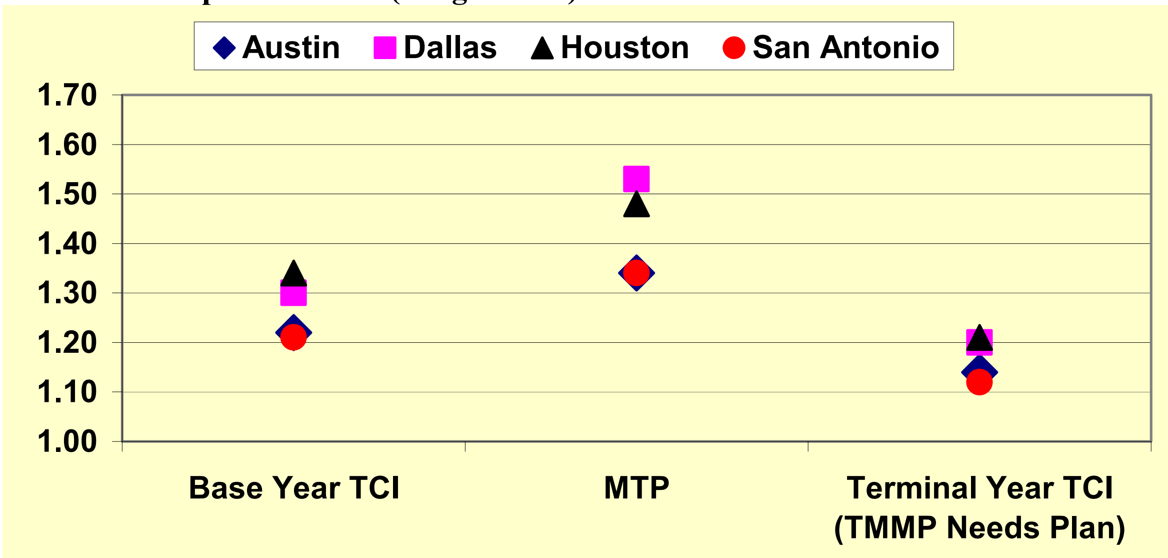
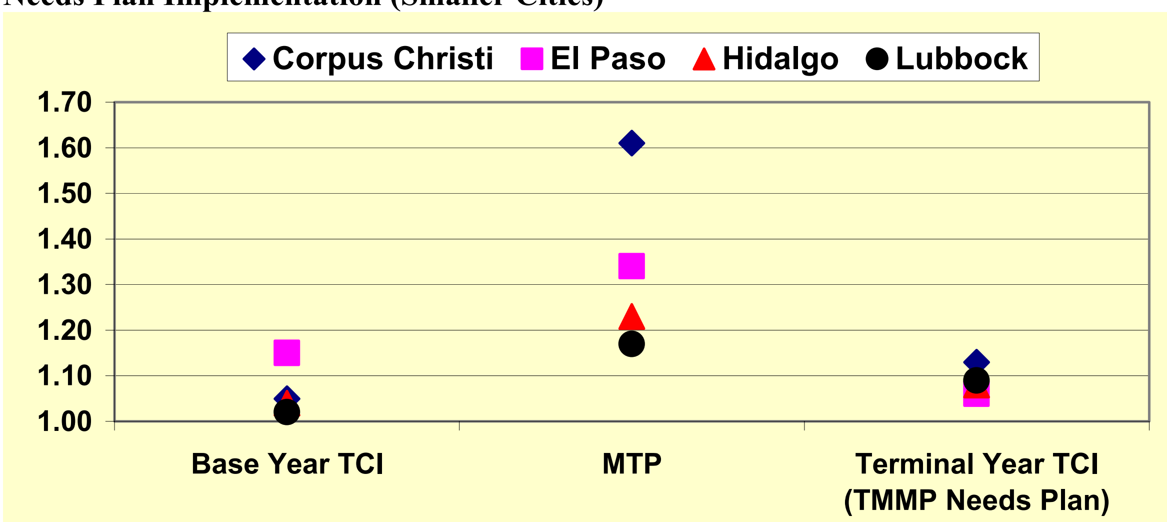


Exhibit 6B: Estimated Change in Texas Congestion Index Value during TMMP Needs Plan Implementation (Smaller Cities)



As shown in Exhibit 7 below, $108 billion in funding over the next 25 years is anticipated for projects included as a part of the Metropolitan Transportation Planning and funding process. (These funds include both state and local sources). The “Additional State and Local Funding Required” line represents the difference between the cost to achieve the mobility scenarios and the amount of funding anticipated – i.e., the amount of additional funding that must be secured in order to achieve the various mobility goals. In sum, in order to meet the Needs-Based funding level a funding increase of approximately $66 billion over the next 25 years is required.

The federal highway reauthorization bill is scheduled to provide the state with an additional $12.2 billion in funding over 25 years. If that funding comes to pass, the amount required to meet the "TMMP Needs" scenario would be reduced from $66.2 billion to $54 billion. However, the reauthorization bill expires after five years. While the bill contemplates that the new funding is permanent, there are no guarantees after five years. Furthermore, increased funding during the five years of the bill is problematic as some estimates show the Highway Trust Fund reaching a zero balance before five years.

Exhibit 7: Estimated Total 25-Year Cost of Alternative Mobility Scenarios

	MTP	Maintain Existing Mobility	Meet TMMP Needs Excluding Pavement Rehabilitation
Total Scenario Cost	108.3	123.0	174.5
Less Current Anticipated Funding	-108.3	-108.3	-108.3
Additional State and Local Funding Required	0.0	14.7	66.2

Note: The "MTP" scenario includes costs for planned reconstruction. The "Meet TMMP Needs" scenario includes no additional rehabilitation costs beyond what is included in the MTP.

As noted previously, the $66 billion in total need represents both state and locally-funded projects. **The question then arises as to the proportion of the $66 billion that might be estimated to be state funding (from fuel taxes, vehicle registration fees, sales taxes on lubricants, and federal transfers) and what portion must be funded from local and/or other sources. This assumption is critical because it provides an estimate of the new funding required at the state level in order to construct the state roadway necessary to meet the mobility targets.**

In preparing this analysis, the following state and local/other funding share arrangements were considered:

- Maintain the existing share: Two-thirds state and one-third local/other funding.

- Toll funds increase the local share: 1/3 state and 2/3 local/other funding.

- Equal share between state and local/other funding sources.

Ultimately, for the purposes of this analysis, it was estimated that approximately two-thirds of the $66 billion in new required costs would be state funds and one-third of the funds required to meet the mobility targets would come from local/other sources maintaining the existing share arrangement. Under that assumption, the total cost to the state to achieve the TMMP mobility goals is estimated to be $44 billion over 25 years (or $32 billion if full funding of the federal highway reauthorization bill is realized).

An Important Note: Reconciling This Section of the GBC Report to TxDOT Estimates of Need

As discussed, this report identifies $66 billion in unfunded need over the next 25 years in order to meet the Texas Metropolitan Mobility Plan mobility goals in the state's eight largest urban areas. The Texas Department of Transportation (TxDOT) has identified a total of $86 billion in need over the same period of time. The difference between the two numbers is that TxDOT's estimate of $86 billion in unfunded need includes $68 billion in the urban areas covered by this report (as compared to the $66 billion estimate produced by the GBC), plus $9 billion in need in "other" urban areas, plus $9 billion in need in rural areas of the state. (The Texas Urban Mobility Plan, to be published soon, is likely to identify $2 to $3 billion in "other" urban area need, as opposed to the $9 billion estimated by TxDOT.)

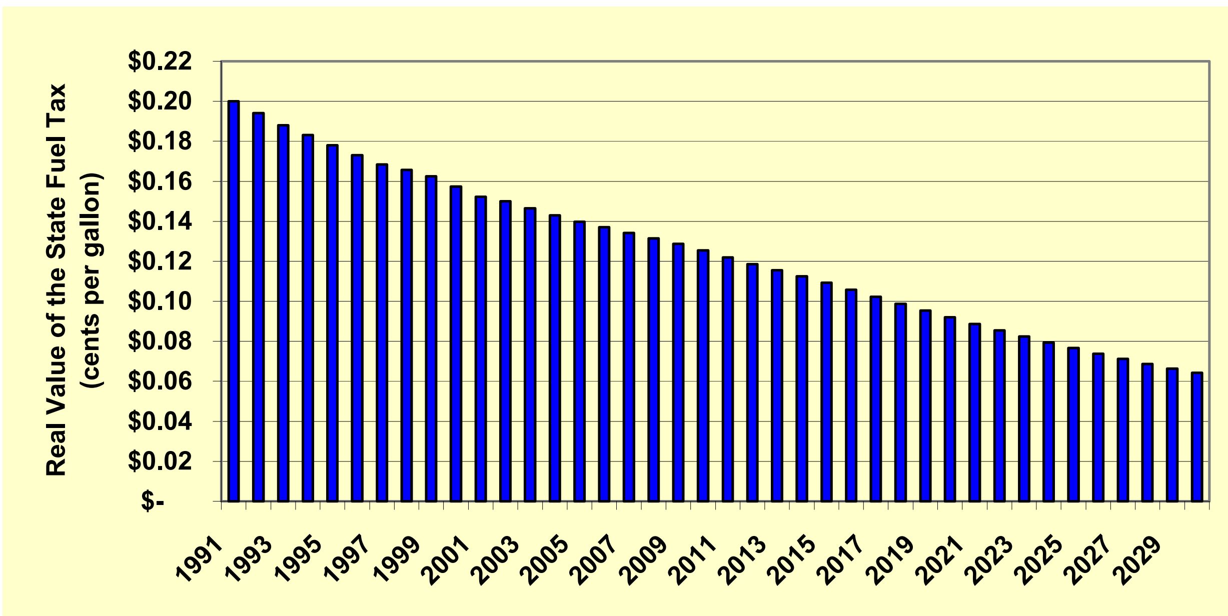
In sum then, when comparing like areas, the real difference between the GBC estimate and the TxDOT estimate for the eight largest urban areas of the state is $1.8 billion, or less than 3 percent ($66 billion versus $68 billion).

While this report focuses primarily on the eight urban areas covered in the Texas Metropolitan Mobility Plan, the additional $12 billion in estimated additional need in other urban areas in rural Texas is also addressed in brief.

How to Close the Gap?

One way to close the estimated $44 billion state highway funding gap in the eight largest urban areas is to raise the fuel tax. However, while the fuel tax has proven to be a very equitable means of assessing cost to the actual users of the roadway system, it continually loses value to inflation over time because it is assessed on a gallon of fuel rather than on the price of fuel. For example, the state fuel tax was last increased in 1991 – from 15 cents per gallon to 20 cents per gallon. Today, because of inflation, the 20 cent per gallon fuel tax enacted in 1991 is now worth approximately 14 cents. (See Exhibit 8.)

Exhibit 8: Historical and Projected Real (Inflation Adjusted) Value of the 20 Cent Per Gallon State Fuel Tax

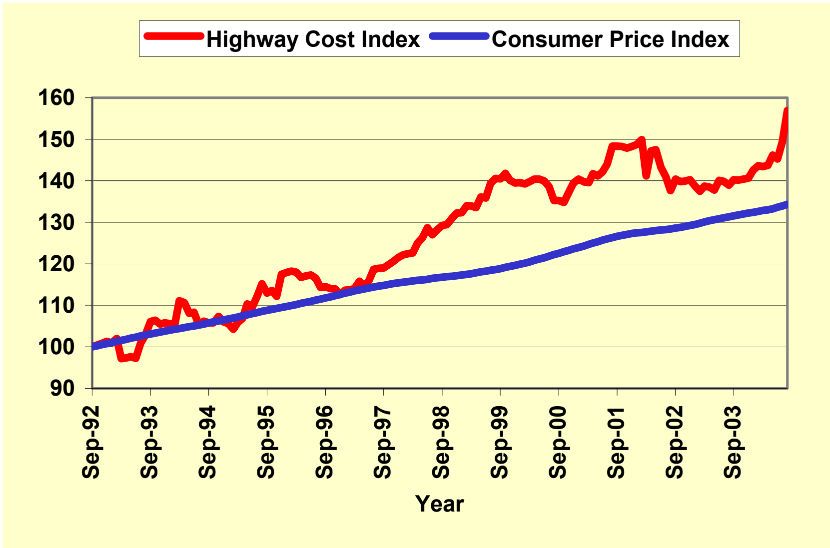


Furthermore, not only does the fuel tax lose buying power due to the general rate of inflation, the year-to-year cost of roadway construction has typically outpaced the general rate of inflation by an average of about one to two percent per year. As a result, the fuel tax loses purchasing power to the general rate of inflation plus the rate by which construction costs increase in excess of the general rate of inflation. The same principles apply to the federal fuel tax which is also assessed on a gallon of fuel (currently at 18.4 cents per gallon).

One solution to the problem is to index the fuel tax to some measure of inflation. The Consumer Price Index (CPI) is an obvious choice in that it is a widely recognized measure of the general rate of inflation. However, as noted earlier, the CPI does not accurately reflect the effect of inflation on highway construction costs as it tends to run, on average, about one percentage point below highway construction cost inflation. Consequently, in order for the fuel tax to keep pace with the cost of constructing and maintaining roadways, it is necessary to index the fuel tax rate to a measure like the

Highway Cost Index (HCI) which actually tracks highway construction costs. (Exhibit 9 shows the historical relationship between the HCI and the CPI.)

Exhibit 9: 12-Month Moving Average: Highway Cost Index and Consumer Price Index from September 1992 to September 2004 (September 1992 = 100)



Note: The Highway Cost Index is maintained by the Texas Department of Transportation. Consumer Price Index data was obtained from the Bureau of Labor Statistics.

Under a state-local/other two-thirds/one-third assumption previously mentioned and if the state fuel tax were indexed to the HCI, an initial state fuel tax of 36 cents per gallon (or a 16 cent per gallon increase) would be required. If the new federal funding is realized and the need is reduced to $32 billion, an initial state fuel tax of 32 cents (or an increase of 12 cents per gallon) is required. (See Exhibit 10.)

Exhibit 10: Alternative Mix of State and Local/Other Funds and Fuel Tax Increase Necessary to Close the $66 Billion Funding Gap in the Eight Largest Metropolitan Areas Assuming the State Fuel Tax is Tied to the Impact of Inflation on the Highway Cost Index.

Funding Source	Total Estimated Funding Required (in billions)	Fuels Tax Increase Required
State Funds	44	16 cents per gallon
Local/Other Funds	22	8 cents per gallon
Total	66	24 cents per gallon

Note: This table assumes, by definition, that all of the shortfall would be paid from the fuel tax. Using other sources of new/increased revenue (e.g., vehicle registration fees or bonding of roadway construction) would reduce the required fuel tax increase.

Another approach, in addition to indexing the state fuel tax, would be to raise the state fuel tax by an amount equal to indexing the federal fuel tax. If that were done, an initial fuel tax of 28 cents per gallon (or an increase of 8 cents per gallon) would be required in order to meet the $44 billion "TMMP Need" figure.

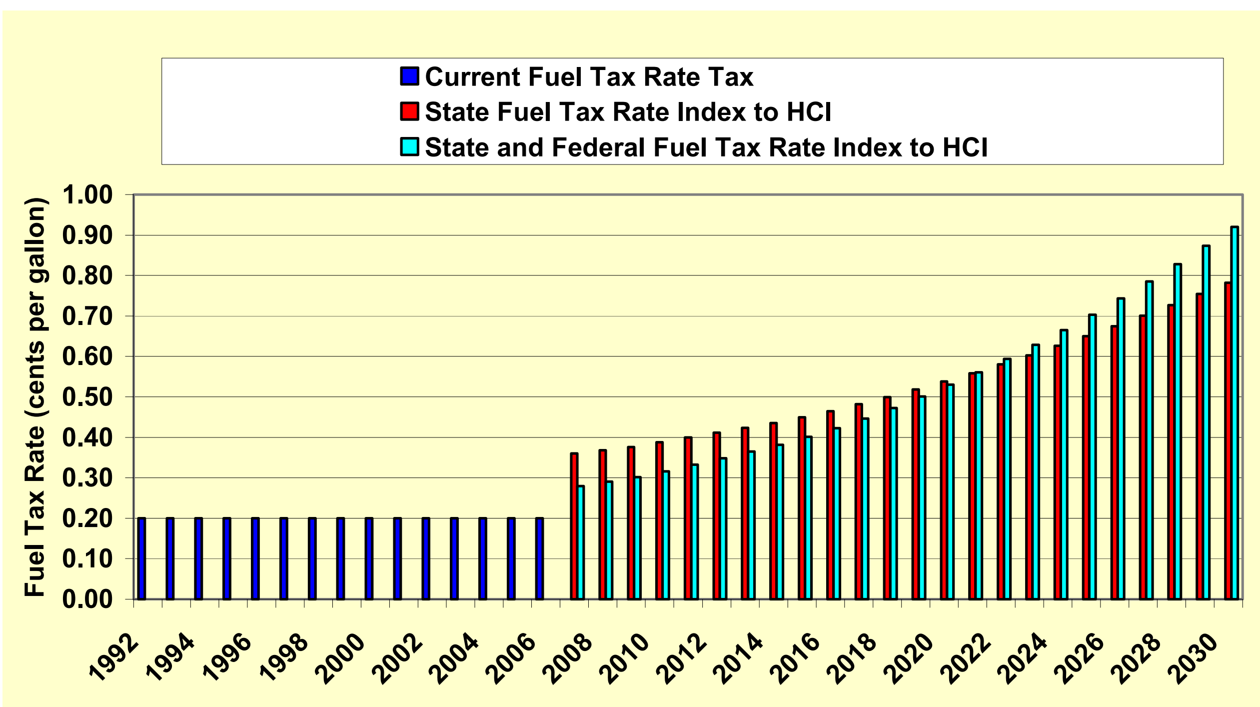
Exhibit 11: Alternative Mix of State and Local/Other Funds and Fuel Tax Increase Necessary to Close the $66 Billion Funding Gap in the Eight Largest Metropolitan Areas Assuming the State Fuel Tax is Tied to the Effects of Inflation on the Highway Cost Index for Both the State and Federal Fuel Taxes

Funding Source	Total Estimated Funding Required (in billions)	Fuels Tax Increase Required
State Funds	44	8 cents per gallon
Local/Other Funds	22	7 cents* per gallon
Total	66	15 cents per gallon

**Note: Seven cents is required to cover cash flow shortages in early years. Tax can be reduced in later years.*

Exhibit 12 below shows the projected track over 25 years of the state fuel tax if it were indexed to Highway Cost Index. Also shown is the projected tax rate if both the state and federal fuel tax were tied to the Highway Cost Index.

Exhibit 12: Current and Alternative Fuel Tax Rates Necessary to Fund $44 Billion in State Need in the Eight Largest Metropolitan Areas



The following exhibit shows costs to achieve the various mobility scenarios on an annual basis. These figures are averages only. Clearly, in reality, there may be significant variation in expenditures from one year to the next based on the type and number of projects underway in any given year.

Exhibit 13: Estimated Annual Cost by Scenario (Average Year of 25 Years)

Metro Region	MTP (in billions)	TMMP Needs Plan (in billions)
Austin	0.38	0.99
Corpus Christi	0.02	0.05
Dallas-Ft. Worth	1.80	2.83
El Paso	0.10	0.25
Hidalgo	0.04	0.08
Houston	1.88	2.26
Lubbock	0.05	0.05
San Antonio	0.07	0.46
TOTAL	4.33	6.98
Anticipated Funding	4.33	4.33
Additional State and Local Funding Required	0.00	2.65

Note: The figures above represent average annual expenditures. Over 25 years, under the MTP, $108 billion in funding is anticipated ($4.33 billion x 25 years). In order to meet the TMMP needs plan, additional state and local funding requirements total $66 billion over 25 years ($2.65 billion x 25 years). [See Exhibit 7.]

The cost of improving mobility is estimated as a function of increasing the number of lane-miles in areas where congestion is worst. The following table shows the number of existing lane miles (minor arterials, principal arterials, freeways, and interstates) in the current system and the number of lane-miles required for the system if the MTP or the TMMP Needs-Based plan is implemented.

As stated earlier, lane-miles were used as a way to estimate the cost of the programs, projects, policies and partnerships that will be required to address the congestion problems. This study does not suggest that lane-miles of roadway are the only way to solve the problem, only that they are the easiest method to estimate the size of the problem. However, it should be noted that while lane-miles of roadway are used as a measure, it is also the case that they do carry in excess of 97 percent of all trips. Transit, in the form of buses and rail, carry the remaining 3 percent – and buses themselves use the roadway system.

The exhibit below shows the number of lane-miles that would need to be added to the system over 25 years in order to meet each of the alternative mobility scenarios.

Exhibit 14: Estimated Lane-Miles Needs in 25 Years Under Alternative Congestion Scenarios

Region	Initial TCI	MTP TCI	TMMP Needs TCI	MTP Miles	TMMP Needs Miles	Difference Between MTP and TMMP Needs
Austin	1.26	1.44	1.14	8,423	12,104	3,681
Corpus Christi	1.04	1.61	1.13	2,273	2,562	289
Dallas-Ft. Worth	1.31	1.53	1.20	24,706	27,876	3,170
El Paso	1.16	1.34	1.06	2,940	4,604	1,664
Hidalgo	1.05	1.23	1.08	1,410	3,609	2,199
Houston	1.36	1.48	1.21	30,382	32,301	1,919
Lubbock	1.04	1.17	1.09	1,625	1,947	322
San Antonio	1.24	1.47	1.12	4,356	6,950	2,594
AVERAGE TCI	**1.25**	**1.48**	**1.18**			
TOTAL LANE MILES				**76,115**	**91,953**	**15,838**

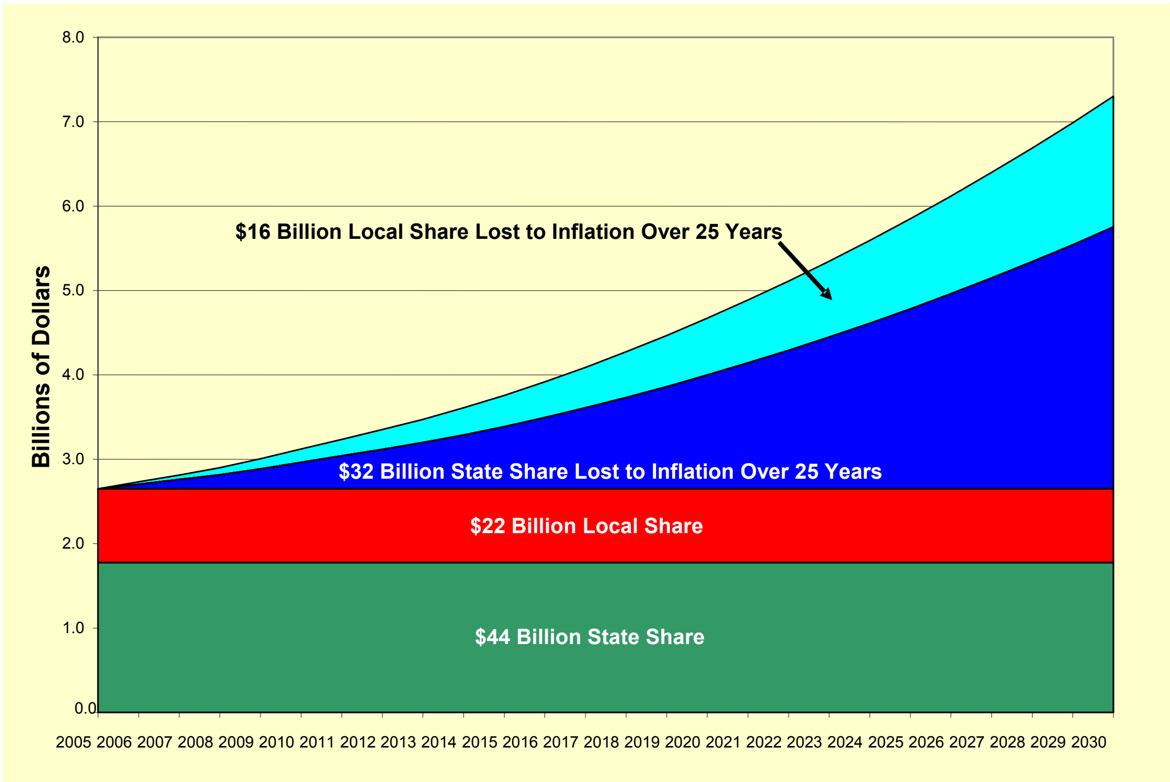
Note: MTP TCI represents the estimated TCI once current Metropolitan Transportation Plan is implemented. Needs TCI represents the estimated TCI if the TMMP Needs-Based Plan is implemented.

The Impact of Inflation on Vehicle Registration Fees and Roadway Construction Costs

As noted earlier, because the fuel tax is a tax on the quantity of fuel purchased rather than the price, the tax loses buying power to inflation over time. Much the same situation exists with respect to vehicle registration fees because they are based on vehicle weight. Furthermore, the rate of roadway construction inflation in recent years has outpaced the general rate of inflation by an estimated one to two percent per year. Indexing vehicle registration fees to account for these losses in purchasing power would help further insulate the state against the impact of cost increases.

Without such indexing, as shown in Exhibit 15 below, an estimated $48 billion will be lost to inflation over the course of 25 years. Said another way, the unfunded cost of achieving the mobility goals increases from an estimated $66 billion over 25 years to an estimated $114 billion.

Exhibit 15: Estimated Effect of Inflation on Unfunded Cost of Achieving Mobility Goals in the State's Eight Largest Urban Areas



There is a full discussion following of the economic benefits associated with meeting the "TMMP Needs" mobility scenario. However there is one other significant benefit associated with raising and indexing the fuel tax sufficient to meet the "TMMP Needs" scenario. The beneficiary is public education.

By constitutional provision, one-quarter of the revenue raised by the fuels tax is dedicated to public education. By raising and indexing the tax to meet the "TMMP Needs" scenario, an additional $50 billion is raised for public education over 25 years. Exhibit 16 below shows a year-by-year estimate of the revenue benefits to both transportation and public education of meeting the "TMMP Needs" scenario with an indexed fuel tax. (In the example shown, only the state fuel tax is indexed.)

Exhibit 16: Estimated Increase in Highway and Education Funding by Year as a Result of Addressing the $44 Billion Highway Funding Gap in the State's Eight Largest Urban Areas (in billions, nominal $)

Year	Highway Share Current Revenue Projection from Current Fuel Tax $0.20 Fuel Tax (Flat Tax)	Education Share Current Revenue Projection from Current Fuel Tax $0.20 Fuel Tax (Flat Tax)	Highway Share Future Revenue Projection from New Fuel Tax $0.36 Fuel Tax (Indexed Tax)	Education Share Future Revenue Projection from New Fuel Tax $0.36 Fuel Tax (Indexed Tax)	Net Gain for Transportation	Net Gain for Public Education
2007	2.4	0.8	3.4	1.1	1.0	0.3
2008	2.5	0.8	3.6	1.2	1.1	0.4
2009	2.6	0.9	3.9	1.3	1.3	0.4
2010	2.6	0.9	4.2	1.4	1.5	0.5
2011	2.7	0.9	4.5	1.5	1.8	0.6
2012	2.8	0.9	4.9	1.6	2.1	0.7
2013	2.9	1.0	5.3	1.8	2.4	0.8
2014	3.0	1.0	5.7	1.9	2.7	0.9
2015	3.1	1.0	6.2	2.1	3.1	1.0
2016	3.2	1.1	6.7	2.2	3.5	1.2
2017	3.3	1.1	7.3	2.4	4.0	1.3
2018	3.3	1.1	7.9	2.6	4.6	1.5
2019	3.4	1.1	8.6	2.9	5.2	1.7
2020	3.5	1.2	9.4	3.1	5.8	1.9
2021	3.6	1.2	10.2	3.4	6.6	2.2
2022	3.7	1.2	11.1	3.7	7.4	2.5
2023	3.8	1.3	12.1	4.0	8.3	2.8
2024	4.0	1.3	13.2	4.4	9.2	3.1
2025	4.1	1.4	14.3	4.8	10.2	3.4
2026	4.2	1.4	15.5	5.2	11.4	3.8
2027	4.3	1.4	16.9	5.6	12.6	4.2
2028	4.4	1.5	18.3	6.1	13.9	4.6
2029	4.5	1.5	19.8	6.6	15.3	5.1
2030	4.7	1.6	21.4	7.1	16.8	5.6
TOTAL	**$82.7**	**$27.6**	**$234.3**	**$78.1**	**$151.6**	**$50.5**

Note: The $151.6 billion in "Net Gain for Transportation" represents $66.2 billion in needed additional improvements over 25 years subject to a projected annual inflation of 4.6 percent over the that period.

What about the Rest of the State?

As noted earlier, TxDOT has produced estimates that indicate the unfunded needs in other urban areas of Texas are estimated to be $9 billion over the next 25 years. In addition, the same study indicates that unfunded needs in rural Texas also amount to $9 billion over the same period of time.

However, a more detailed study of other urban areas of the state is presently underway. Called the Texas Urban Mobility Plan (analogous to the Texas Metropolitan Mobility Plan that served as the basis for the preceding discussion of need and costs in this report), preliminary results of the study indicate that the unfunded need is approximately $3 billion. No other estimate of needs in rural Texas outside of that conducted by TxDOT is currently underway.

Consequently, taking the results of this study:

- $44 billion in need over 25 years ($66 billion in total need, of which $44 billion is estimated to be on state-funded roadways),
- plus $3 billion in unfunded need in other urban areas,
- plus an assumed $9 billion in need in rural areas of Texas

brings the total unfunded need to an estimated $56 billion over the next 25 years.

The funding scenario discussed above only addresses the $44 billion in need identified in the state's eight largest areas because this report was designed to focus on those areas' needs (see pages 2 through 9 of this report). However, it should be noted that in order to address the *total* state need, an additional 4 cents would be need to be added to the estimated additional 28 cents fuel tax increased necessary to fund the metropolitan need as shown in Exhibit 17 below.

Exhibit 17: Total Statewide Unfunded Need and Additional Fuel Tax Necessary Assuming the State Fuel Tax is Tied to the Effect of Inflation on Both the State and Federal Fuel Tax.

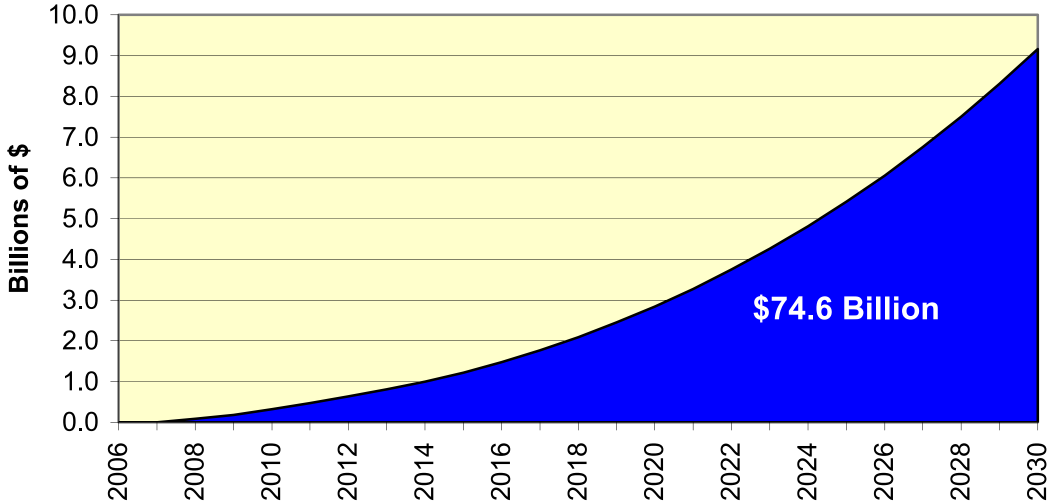
	Unfunded Need	Additional State Fuel Tax Necessary
8 Metropolitan Areas	$44 billion	8 cents
17 Other Urban Areas	$ 3 billion	1 cent
Rural Texas	$ 9 billion	3 cents
Total	$56 billion	12 cents

Another Option: The State Motor Fuel Tax and the Texas Mobility Fund

Another way to address the shortfall identified above is to adjust the state motor fuels tax (currently 20 cents per gallon) by an amount equal to the effect of Highway Cost Index inflation on the combined federal and state motor fuels tax (38.4 cents per gallon). The state has no control over the federal tax rate but state transportation revenue depends on both the state and federal fuel taxes. Such an indexing mechanism will protect the purchasing power of the motor fuels tax against inflation. (See page 12 of this report for a discussion of the effects of inflation on the purchasing power of the motor fuels tax.)

If the 20 cent per gallon fuel tax rate was not raised, but simply adjusted in the future by a rate equal to 80 percent of the Highway Cost Index (HCI), the increase would be sufficient to borrow the estimated $44 billion shortfall. (See Exhibit 18.)

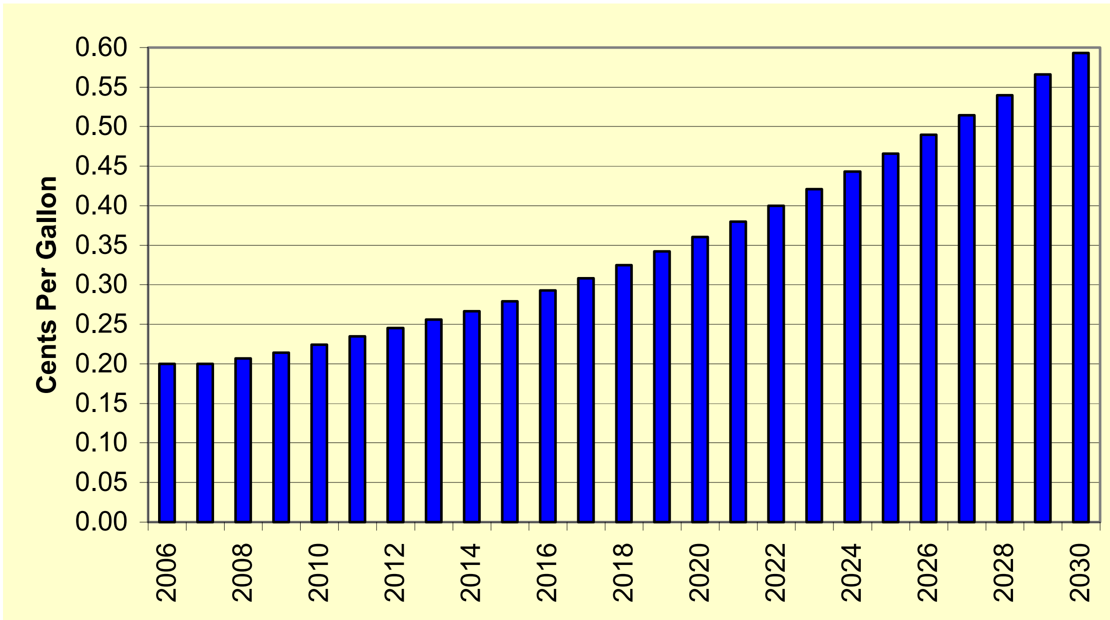
Exhibit 18: Estimating Annual and Cumulative Revenue Gain Resulting From Annually Increasing the State and Federal Fuel Tax by 80 Percent of the Annual Increase of the Highway Cost Index (Sufficient to Finance $44 Billion in Improvements in 2006 Dollars).



Note: This figure represents only the portion of the motor fuel tax constitutionally dedicated to transportation. Additional revenue also would be generated for education.

As shown in Exhibit 19, by allowing the fuel tax to rise by 80 percent of the HCI the fuel tax would increase over the 25 year period from 20 cents per gallon in 2007 to 59 cents per gallon by 2030.

Exhibit 19: Estimated Future State Fuel Tax Rate Resulting from Indexing the State and Federal Fuel Tax to 80 Percent of the Annual Increase in the Highway Cost Index (Sufficient to Borrow $44 Billion in Improvements in 2006 Dollars Plus All Bond Issuance Costs and Reserve Requirements).



Note: This figure represents the total state fuel tax including money constitutionally dedicated to both transportation and education.

If this incremental tax revenue were then to be deposited in the Texas Mobility Fund (or a similar type of account), it would be sufficient to support the issuance of $90 billion in bonds through FY2030, which, in turn, is enough to finance the $44 billion in needed improvements over 25 years in 2006 dollars. Furthermore, the bond debt could be serviced entirely with the proceeds from the incremental fuel tax increase. Exhibit 20a shows the necessary tax rate and the bond issuance and payment schedule sufficient to address the $44 billion shortfall.

Exhibit 20a: Revenues and Costs of Bond Issues Necessary to Finance $44 Billion in Improvements in 2006 Dollars by Indexing the Fuels Tax at 80 Percent Annual Increase in the Highway Cost Index.

Year	Proposed Fuel Tax (cents per gallon)	A Revenue From Incremental Fuel Tax for Transportation	B Bonds Issued for New Capacity	C Debt Service on Principal	D Debt Service on Interest	E Issuance Costs (2% of Issue)	F Debt Service Reserve Fund (10% of Issue)	G Total Cost	H Annual Excess Cash	I Debt Coverage Ratio	J Present Value of New Capacity Improvements
2006	0.20	-	-	-	-	-	-	-	-		-
2007	0.20	-	-	-	-	-	-	-	-		-
2008	0.21	87,578,031	-	-	-	-	-	-	87,578,031		-
2009	0.21	183,156,192	1,067,968,923	-	-	21,359,378	106,796,892	128,156,271	54,999,921	8.57	879,199,610
2010	0.22	320,030,057	1,165,526,367	19,627,293	55,219,275	23,310,527	116,552,637	214,709,732	105,320,326	3.26	911,223,370
2011	0.23	473,032,095	1,669,106,199	42,094,544	114,311,906	33,382,124	166,910,620	356,699,194	116,332,901	2.49	1,262,685,277
2012	0.25	638,257,530	1,865,780,940	74,992,265	198,037,338	37,315,619	186,578,094	496,923,315	141,334,215	2.06	1,372,693,852
2013	0.26	811,116,302	2,014,838,957	113,237,115	289,906,485	40,296,779	201,483,896	644,924,275	166,192,027	1.83	1,452,342,355
2014	0.27	994,396,228	2,107,923,570	156,240,914	387,143,079	42,158,471	210,792,357	796,334,821	198,061,407	1.70	1,486,103,876
2015	0.28	1,216,319,588	2,235,004,168	203,238,896	486,597,406	44,700,083	223,500,417	958,036,802	258,282,787	1.66	1,481,737,750
2016	0.29	1,471,461,789	2,706,240,919	255,067,817	589,785,867	54,124,818	270,624,092	1,169,602,595	301,859,194	1.64	1,702,729,068
2017	0.31	1,762,326,079	3,111,327,548	318,231,969	713,994,357	62,226,551	311,132,755	1,405,585,631	356,740,448	1.61	1,854,917,509
2018	0.32	2,088,434,824	3,546,939,991	392,116,666	855,116,114	70,938,800	354,693,999	1,672,865,579	415,569,245	1.58	2,011,501,644
2019	0.34	2,449,040,254	3,976,727,949	477,829,158	1,014,017,775	79,534,559	397,672,795	1,969,054,287	479,985,967	1.56	2,155,740,397
2020	0.36	2,843,018,075	4,397,397,233	575,878,203	1,189,649,953	87,947,945	439,739,723	2,293,215,824	549,802,251	1.53	2,291,390,242
2021	0.38	3,272,513,697	4,804,356,325	686,743,621	1,380,775,150	96,087,126	480,435,632	2,644,041,530	628,472,167	1.51	2,408,051,681
2022	0.40	3,746,804,519	5,237,477,586	810,852,548	1,585,906,997	104,749,552	523,747,759	3,025,256,856	721,547,663	1.50	2,499,099,699
2023	0.42	4,257,865,399	5,783,731,955	949,373,779	1,805,556,128	115,674,639	578,373,195	3,448,977,742	808,887,657	1.48	2,674,534,591
2024	0.44	4,811,447,894	6,232,123,841	1,105,090,093	2,044,528,806	124,642,477	623,212,384	3,897,473,760	913,974,135	1.47	2,779,381,326
2025	0.47	5,409,909,971	6,371,618,012	1,277,163,985	2,296,862,362	127,432,360	637,161,801	4,338,620,509	1,071,289,462	1.46	2,743,167,220
2026	0.49	6,055,747,730	6,371,618,012	1,467,714,829	2,565,088,643	127,432,360	637,161,801	4,797,397,634	1,258,350,095	1.46	2,650,772,700
2027	0.51	6,755,724,148	6,371,618,012	1,678,235,833	2,849,533,337	127,432,360	637,161,801	5,292,363,332	1,463,360,816	1.45	2,548,607,959
2028	0.54	7,500,006,121	6,371,618,012	1,910,330,147	3,150,518,261	127,432,360	637,161,801	5,825,442,569	1,674,563,552	1.45	2,498,479,245
2029	0.57	8,303,881,117	6,371,618,012	2,166,604,439	3,470,852,284	127,432,360	637,161,801	6,402,050,885	1,901,830,233	1.44	2,406,350,738
2030	0.59	9,162,422,589	6,371,618,012	2,446,237,647	3,803,154,006	127,432,360	637,161,801	7,013,985,814	2,148,436,775	1.44	2,346,058,881
TOTALS		74,614,490,230	90,152,180,542	17,126,901,763	30,846,555,529	1,803,043,611	9,015,218,054	58,791,718,956	15,822,771,274		44,416,768,988

Outstanding Bonds as of 2031	73,025,278,779
Less: Balance of Debt Reserve Fund (Column F) Plus Earned Interest	11,490,924,037
Less: Excess Cash (Column H) Plus Earned Interest	19,774,083,575
Net Outstanding Debt as of 2031	41,760,271,167

Note 1: Borrowing costs are assumed to be 5.5 percent.
Note 2: The Consumer Price Index is assumed to increase by an average of 3.2 percent per year over the planning period.
Note 3: The Highway Cost Index is estimated to increase by an average of 3.4 percent per year over the planning period.
Note 4: Column A of this figure represents additional revenue by indexing the combined state and federal motor fuel tax at 80 percent annual increase in the Highway Cost Index, or 2.7 percent per year.
Note 5: Column A of this figure represents only the portion of the motor fuel tax constitutionally dedicated to transportation. Additional revenue also would be generated for education.
Note 6: Reinvestment of excess cash and debt reserve fund is assumed to be 80 percent of the bond rate.
Note 7: Bonds are issued annually equal to an amount necessary to pay for the inflated cost of improvements.

Again, this could be accomplished without an increase in the 20 cent per gallon base motor fuels tax rate, but by simply indexing the state and federal motor fuels tax rates to a measure that accounts for 80 percent of the future highway construction cost inflation, or a projected 2.7 percent per year.

Earlier, this report focused on a possible identified need of as much as $56 billion statewide. Exhibit 20b shows the required tax rate and bond issuance and payment schedule sufficient to address that need. To borrow this amount you would need to adjust the tax rate annually by 90 percent of the HCI, or a projected 3.1 percent per year.

Exhibit 20b: Revenues and Costs of Bond Issues Necessary to Finance $56 Billion in Improvements in 2006 Dollars by Indexing the Fuels Tax at 90 Percent Annual Increase in the Highway Cost Index.

		A	B	C	D	E	F	G	H	I	J
Year	Proposed Fuel Tax (cents per gallon)	Revenue From Incremental Fuel Tax for Transportation	Bonds Issued for New Capacity	Debt Service on Principal	Debt Service on Interest	Issuance Costs (2% of Issue)	Debt Service Reserve Fund (10% of Issue)	Total Cost	Annual Excess Cash	Debt Coverage Ratio	Present Value of New Capacity Improvements
2006	0.20	-	-	-	-	-	-	-	-		-
2007	0.20	-	-	-	-	-	-	-	-		-
2008	0.21	97,650,000	-	-	-	-	-	-	97,650,000		-
2009	0.22	204,529,964	1,190,791,382	-	-	23,815,828	119,079,138	142,894,966	61,634,998	8.59	980,312,532
2010	0.23	358,030,009	1,303,346,033	19,627,293	55,219,275	26,066,921	130,334,603	231,248,092	126,781,917	3.55	1,018,972,541
2011	0.24	530,250,790	1,871,853,880	42,094,544	114,311,906	37,437,078	187,185,388	381,028,916	149,221,875	2.74	1,416,064,680
2012	0.25	716,911,187	2,100,143,607	74,992,265	198,037,338	42,002,872	210,014,361	525,046,835	191,864,352	2.28	1,545,119,341
2013	0.26	912,876,368	2,276,227,267	113,237,115	289,906,485	45,524,545	227,622,727	676,290,872	236,585,496	2.03	1,640,757,073
2014	0.28	1,121,332,794	2,389,694,310	156,240,914	387,143,079	47,793,886	238,969,431	830,147,310	291,185,484	1.90	1,684,754,621
2015	0.29	1,374,588,556	2,542,018,601	203,238,896	486,597,406	50,840,372	254,201,860	994,878,534	379,710,023	1.86	1,685,278,701
2016	0.31	1,666,822,757	3,088,323,397	255,067,817	589,785,867	61,766,468	308,832,340	1,215,452,492	451,370,265	1.84	1,943,130,037
2017	0.32	2,001,260,542	3,563,645,355	318,231,969	713,994,357	71,272,907	356,364,536	1,459,863,768	541,396,774	1.81	2,124,581,248
2018	0.34	2,377,723,196	4,078,296,299	392,116,666	855,116,114	81,565,926	407,829,630	1,736,628,336	641,094,860	1.79	2,312,838,596
2019	0.36	2,795,698,617	4,590,767,889	477,829,158	1,014,017,775	91,815,358	459,076,789	2,042,739,080	752,959,537	1.77	2,488,604,682
2020	0.38	3,254,205,463	5,096,994,690	575,878,203	1,189,649,953	101,939,894	509,699,469	2,377,167,519	877,037,944	1.74	2,655,935,609
2021	0.41	3,756,054,053	5,591,254,497	686,743,621	1,380,775,150	111,825,090	559,125,450	2,738,469,311	1,017,584,743	1.72	2,802,462,781
2022	0.43	4,312,491,958	6,119,784,725	810,852,548	1,585,906,997	122,395,694	611,978,472	3,131,133,713	1,181,358,245	1.71	2,920,098,828
2023	0.46	4,914,447,923	6,785,473,256	949,373,779	1,805,556,128	135,709,465	678,547,326	3,569,186,698	1,345,261,225	1.70	3,137,763,486
2024	0.48	5,569,050,162	7,340,542,522	1,105,090,093	2,044,528,806	146,810,850	734,054,252	4,030,484,001	1,538,566,161	1.69	3,273,710,108
2025	0.51	6,279,471,785	7,982,536,685	1,277,163,985	2,296,862,362	159,650,734	798,253,669	4,531,930,750	1,747,541,035	1.68	3,436,714,651
2026	0.54	7,049,075,624	8,663,225,275	1,467,714,829	2,565,088,643	173,264,505	866,322,527	5,072,390,506	1,976,685,119	1.68	3,604,145,919
2027	0.57	7,886,397,916	9,384,921,888	1,678,235,833	2,849,533,337	187,698,438	938,492,189	5,653,959,797	2,232,438,119	1.67	3,753,910,949
2028	0.60	8,779,983,686	10,210,713,485	1,910,330,147	3,150,518,261	204,214,270	1,021,071,348	6,286,134,026	2,493,849,661	1.67	4,003,889,698
2029	0.63	9,748,708,925	10,896,817,585	2,166,604,439	3,470,852,284	217,936,352	1,089,681,759	6,945,074,833	2,803,634,092	1.66	4,115,369,909
2030	0.66	10,787,039,517	11,813,104,649	2,446,237,647	3,803,154,006	236,262,093	1,181,310,465	7,666,964,210	3,120,075,306	1.66	4,349,639,138
TOTALS		86,494,601,794	118,880,477,278	17,126,901,763	30,846,555,529	2,377,609,546	11,888,047,728	62,239,114,565	24,255,487,229		56,894,055,128

Outstanding Bonds as of 2031	101,753,575,515
Less: Balance of Debt Reserve Fund (Column F) Plus Earned Interest	15,233,285,804
Less: Excess Cash (Column H) Plus Earned Interest	30,143,936,813
Net Outstanding Debt as of 2031	56,376,352,898

Note 1: Borrowing costs are assumed to be 5.5 percent.
Note 2: The Consumer Price Index is assumed to increase by an average of 3.2 percent per year over the planning period.
Note 3: The Highway Cost Index is estimated to increase by an average of 3.4 percent per year over the planning period.
Note 4: Column A of this figure represents additional revenue by indexing the combined state and federal motor fuel tax at 90 percent annual increase in the Highway Cost Index, or 3.1 percent per year.
Note 5: Column A of this figure represents only the portion of the motor fuel tax constitutionally dedicated to transportation. Additional revenue also would be generated for education.
Note 6: Reinvestment of excess cash and debt reserve fund is assumed to be 80 percent of the bond rate.
Note 7: Bonds are issued annually equal to an amount necessary to pay for the inflated cost of improvements.

It is also worth noting that the state could further accelerate the construction of badly needed projects by using some of the bond proceeds in public/private partnerships.

It is also important to remember that one of the tangible benefits of improving mobility is the increased fuel efficiency that results from more efficient travel speeds. As noted elsewhere in this report, it is estimated the value of the wasted fuel in the State's eight largest urban areas due to traffic congestion is $37.4 billion over 25 years. The fuel savings alone resulting from reducing this waste offsets 55 percent of the cost of the total state and local improvements. The value of the delay as a result of traffic congestion in these eight urban areas is estimated to be $103.6 billion over 25 years. Exhibit 21a shows the additional revenue derived from the incremental fuel tax increase necessary to finance $44 billion in improvements compared to the annual benefits from time and fuel savings resulting from improved mobility. (Exhibit 21a shows benefits only from 2011 to 2030, not the full 25 years referenced above.)

Exhibit 21a: Annual Cost of $44 Billion in Improvements in 2006 Dollars vs. Annual Benefits from Time and Fuel Savings (Assumes $2.80/gallon Fuel Price; shows benefits only from 2011 to 2030, not the full 25 years referenced above.)

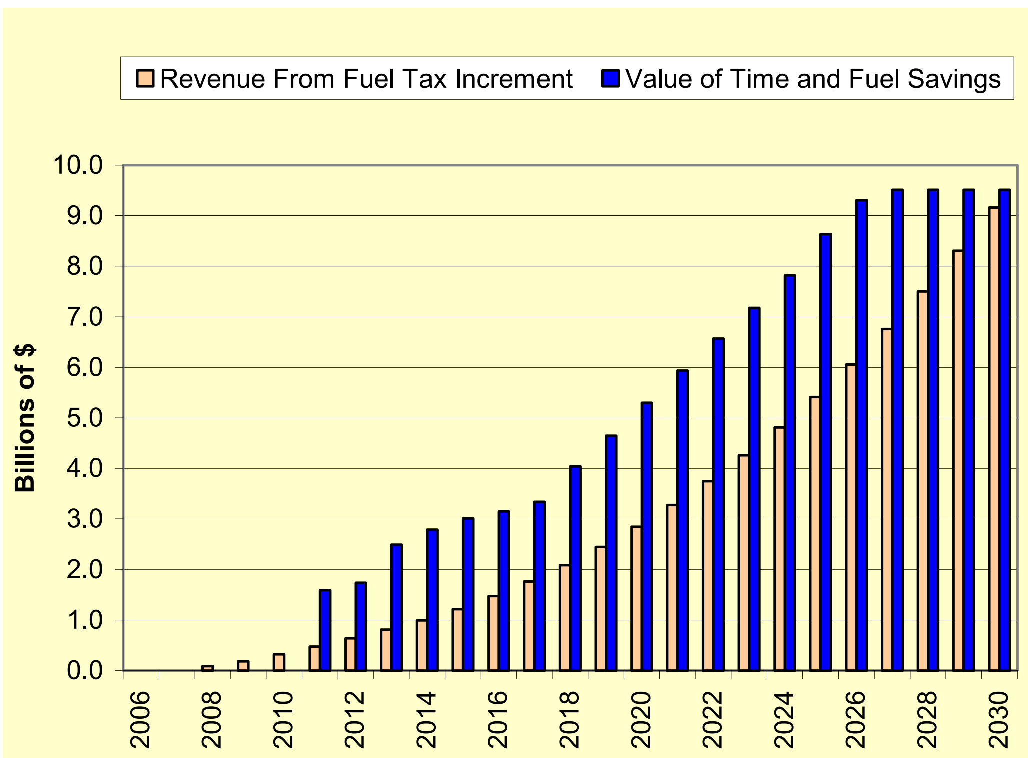
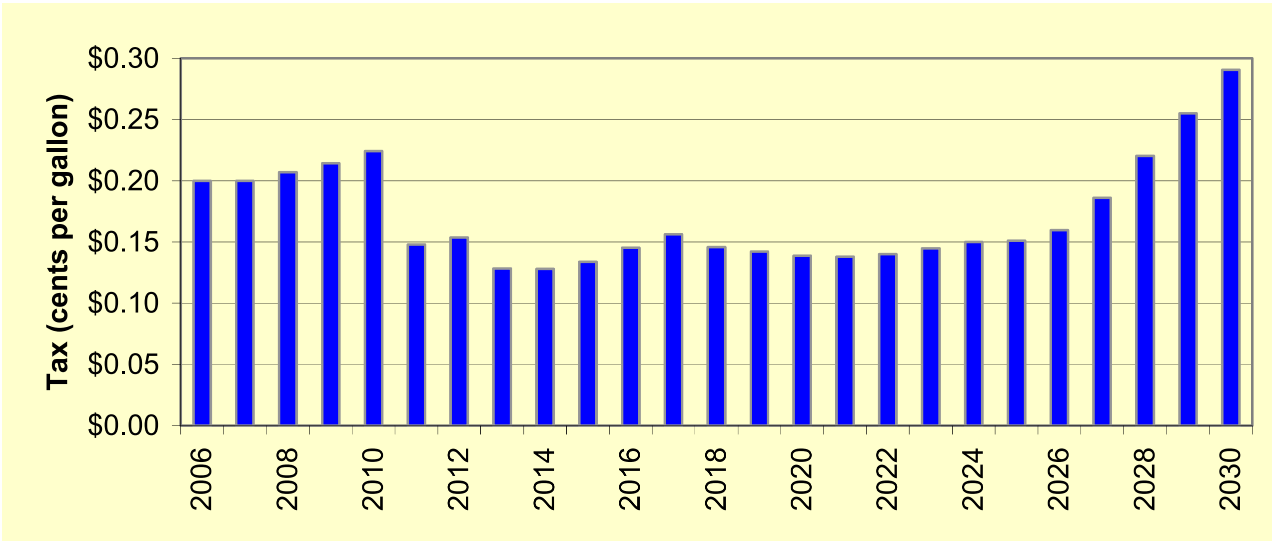


Exhibit 21b below shows the net value of the fuel tax when taking the benefits of time and fuel savings into account (i.e., the value of the motor fuel tax minus the benefits in fuel and time savings expressed in cents-per-gallon).

Exhibit 21b: Net Cost of Fuel Tax Per Gallon ($2.80/gallon Fuel Price)



Note: Net Cost is the difference between the total state HCI-adjusted fuel tax (including money constitutionally dedicated to both transportation and education) less benefits derived from fuel and time savings.

The Benefits

The preceding sections of this report have dealt with the costs to achieve the various mobility scenarios/goals. In this section, the benefits are addressed. Those benefits accrue to five primary areas.

- The economic impact of the construction activity expressed in terms of increased employment, income and contribution to the state economy.
- Savings from increased economic efficiencies as a result of improving mobility. These savings come from lower production costs for businesses resulting from lower delivery costs of both inputs and finished goods.
- The economic impact of the increase in economic efficiencies resulting from these lower costs mean businesses can offer more competitive prices which translate into a larger market share. That, in turn, generates more demand for products, more production, increased employment, income to employees, and profits to the business.
- Time savings to individuals as a function of reduced commute times and an increase in travel speeds.
- Fuel savings to individuals as a result of more efficient fuel burn from lower congestion levels.

To arrive at a result of the economic impact of construction, the estimated amount that will be spent in the study area was determined by using the historical average from 1996 through 2000 of the proportion of state highway funds spent in the study area (this period was chosen because 2000 is the base year for calculations used in this study) multiplied by total state highway expenditures, less the amount expected to be spent in local areas under current MTP in the eight areas. The balance, termed the "Net Estimated Spending Gap" is the amount of new funds required to meet the TMMP Needs-Based goals. The gap is estimated to be $66 billion in the state's eight largest urban areas over 25 years, an average of almost $2.65 billion per year shared between state and local governments.

This figure was used to estimate the change in the value of production in the Texas economy for the purpose of calculating economic impact. The result of those calculations is shown below in Exhibit 22.

As seen in Exhibit 22, an additional $2.65 billion in annual highway construction expenditures in the state's eight largest urban areas (or $66 billion in total expenditures averaged over 25 years) could be expected to have an economic impact of approximately $322 billion on the Texas economy over 25 years.

Exhibit 22: New Jobs, Annual Income Increase and Total Economic Impact from Annual Highway Construction Expenditures Necessary to Meet the TMMP Needs-Based Goal (Expressed in billions of dollars)

New Annual State and Local Expenditures on Transportation:	**$2.65 billion**
(Based on $66 billion in expenditures over 25 years.)	
NEW JOBS	
Highway Construction Jobs:	58,000
Indirect Jobs:	55,000
Total Direct and Indirect Jobs:	113,000
AGGREGATE ANNUAL INCOME INCREASE	
Aggregate Annual Personal Income from Highway Construction:	$1.6 billion
Aggregate Annual Personal Income from Indirect Jobs:	$1.7 billion
Aggregate Annual Personal Income Economy Wide:	$3.3 billion
ECONOMIC ACTIVITY OVER 25 YEARS	
Increase in Economic Activity Economy-Wide over 25 Years	$ 322.1 billion

How does an annual expenditure of an additional $2.65 billion on roadways ultimately generate $322.1 billion in economic impact over 25 years? Using an input/output model that replicates the Texas economy, the additional expenditure of $2.65 billion per year generates jobs in order for the work to be accomplished, in this instance an estimated 113,000 jobs. Those employees are paid estimated total wages of $3.3 billion annually. The $322.1 billion increase in economic activity occurs over 25 years and includes the primary, secondary, and tertiary effects of spending $2.65 billion per year for 25 years (or $66.2 billion in total) on highway construction. This economy-wide impact includes direct impacts such as spending on labor, equipment, and materials on the construction activity. It would also include secondary impacts such as the spending by those who earn salaries from work performed directly or indirectly as a result of the construction activity. Finally, it includes the effects of income/spending by those who received income from the expenditures of those who were directly or indirectly associated with construction activity.

There are other impacts as well. For example, the primary reason, of course, for making the expenditures in the first place is to improve mobility. One of the major ways that improving mobility manifests itself in an economic sense is in improving business efficiencies. As an illustration, if it takes a delivery truck only 30 minutes to make a delivery instead of 45 minutes, there are savings in fuel and operating expenses because trucks run more efficiently at normal speeds as opposed to a stop and go environment. In addition, there are savings in driver time, allowing more deliveries to be made in an 8-hour day. These, and other similar factors, have the effect of reducing production costs. Lower production costs make goods less expensive and affect consumption in a positive way for business. Further, because Texas competes not only in the national but international economy, the cost savings from improved mobility make Texas goods more competitive in these larger markets. (There are more details on the substantial positive environmental effects of improved mobility included elsewhere in this report.)

In previous research, the return on investment to the general economy of highway expenditures was estimated to be approximately 16 percent annually in the mid-1990s. That is to say that for every $100 spent on highways, there are $16 per year in increased economic efficiencies. Further, that increased efficiency continues to occur every year as long as the roadway improvement is maintained.

For the purposes of this study, the return on investment was calculated at 8 percent rather than 16 percent. This reduction was adopted because the general trend since the advent of the Interstate Highway System is that return on investment has declined. This stands to reason in that the second and subsequent links between two or more markets has a smaller economic impact than the establishment of the first link between those markets. (It should also be noted that some believe this trend in declining return on investment may be reversing to some degree, primarily because of the increased time-sensitive demands of just-in-time inventory practices.)

When the 8 percent rate of return is applied annually to the $2.65 billion average investment in roadway expenditures over 25 years, an increase in business efficiency is created that has an estimated value of $61 billion over the same period.

That improvement in business efficiency ($61 billion) itself has an economic impact for the same reasons as the economic benefits of construction. This economic impact is calculated on the basis of assuming a general rate of return of 6 percent to business (i.e., profit) on operating savings of $61 billion over 25 years. This results in an increase in business profits of $5 billion over that time-period. Consequently, using the same model of the Texas economy over 25 years, the $5 billion increase in profits, resulting from the $61 billion increase in economic efficiency, would yield a positive economic impact of approximately $17 billion economy-wide over that time period. (See Exhibit 23.) That economic effect will, in turn, help support over 7,000 jobs.

Exhibit 23: Estimated Secondary Impact of Increases in Business Efficiencies as a Result of Meeting the TMMP Mobility Goals in the Eight Largest Metropolitan Areas

Benefits Over 25 Years of Improving Business Efficiencies	**$ 5.0 billion**
AGGREGATE ANNUAL INCOME INCREASE OVER 25 YEARS	
Aggregate Annual Personal Income from Direct Jobs:	$2.0 billion
Aggregate Annual Personal Income from Indirect Jobs:	$2.4 billion
Aggregate Annual Personal Income Economy Wide:	$4.4 billion
ECONOMIC ACTIVITY	
Change in Economic Activity for the State	$16.7 billion

Note: Mobility goals defined by the TMMP Needs scenario.

Time and Fuel Savings

Another benefit of improving mobility is the reduction of delay and fuel consumption. As shown in Exhibit 24, by 2025 it is estimated that Texans will spend 954 million hours annually stuck in traffic and while doing so will waste almost 1.6 billion gallons of fuel each year. In 2025, the cost of wasted time and fuel will be almost $17 billion annually. However, if the TMMP Needs-Based Plan is achieved, the total cost of delay will be cut by almost two-thirds. The savings over 25 years associated with improving mobility will amount to over 8 billion hours and 13 billion gallons of fuel, accounting for almost $141 billion in savings.

Exhibit 24: Estimated Time and Fuels Benefit of the TMMP Needs-Based Plan

Congestion Effect		2025 Condition		
	Current Condition	If MTP is Implemented	If Needs-Based Plan is Implemented	25-Year Savings
Hours of Delay (millions)	290	954	333	8,065
Gallons of Fuel Wasted (millions)	476	1,571	542	13,374
Value of Time Wasted (billions of $)	$0.66	$12.26	$4.28	$103.64
Cost of Wasted Fuel (billions of $)	$1.33	$4.40	$1.52	$37.39
Total Cost of Delay (billions of $)	$1.99	$16.66	$5.80	$141.03

Note 1: Savings from implementation of Needs-Based Plan are phased in over 25 years in these calculations. The Value of Time used in these calculations comes from TTI's Urban Mobility Study and is $13.75 per hour. For the purposes of these calculations, the average price of fuel used was $2.80 per gallon.
Note 2: Values in the column labeled "If Needs-Based Plan is Implemented" show increases over the "Current Condition" column as a result of significant increases in population and vehicle-miles traveled. As indicated by the "25-Year Savings" column, there is significant improvement in all measurement categories on a per capita basis.

It should be noted that Exhibit 24 does not include the value of emissions and potential safety benefits associated with improving traffic flow. A more detailed discussion of the emission benefits of reducing traffic congestion is contained in Section 4 of this report.

As shown in Exhibits 25 and 26, the savings associated with improving mobility are substantial. As a result of investing $66 billion over the next 25 years in the roadway networks in our state's eight major metropolitan areas, $400 billion in economic benefits would be derived, plus over $37 billion in fuel savings and over $103 billion in time savings, for an estimated total of $541 billion.

Exhibit 25: Total Savings as a Result of Meeting the TMMP Mobility Goals

Cost:	**Dollars**
Cost of Achieving TMMP Needs-Based Plan	$ 66.2 billion
Savings and Benefits:	
Economic Impact of Construction	$ 322.1 billion
Increased Economic Efficiencies to Business	$ 61.2 billion
Economic Impact of Business Savings	$ 16.7 billion
Fuel Savings	$ 37.4 billion
Time Savings	$ 103.6 billion
TOTAL SAVINGS AND BENEFITS	**$ 541.0 billion**
Net Economic Benefit	**$ 474.8 billion**
Over 25 Years:	
Gallons of Fuel Saved	13.4 billion
Hours of Delay Saved	8.1 billion

Note: Savings from implementation of the Needs-Based Plan are phased in over 25 years. The Value of Time used in these calculations comes from TTI's Urban Mobility Study and is $13.75 per hour. For the purposes of these calculations, the average price of fuel used was $2.80 per gallon.

Some may make the case that the $322 billion economic impact of construction resulting from the investment of $66 billion in public funds should not be counted as a true "benefit." (See Exhibit 25 above.) The rationale is that since the $66 billion is public money, it could be spent on other public capital goods which have approximately the same return. Also, some make the argument that since tax and fee revenues are extracted from the citizenry, if left in private hands, their expenditure by individuals would result in benefits commensurate with benefits associated with spending the money on highway construction.

In the first instance, in Texas, since fuel tax and vehicle fee revenue (the bulk of revenue at issue), by constitutional dedication, can only be spent on transportation maintenance and improvements, the question of benefit derived from the expenditure on one public good versus another does not exist. The funds cannot be spent for another public purpose.

In the second instance, the issue of whether the marginal tax and fee revenue (the $66 billion) would have a commensurate or greater benefit if left in private hands has some validity. However, even if one chooses to disregard the economic impact of $66 billion in highway construction, there is no question that the remaining benefits are both valid and significant.

Discounting the benefits of construction in their entirety, as shown above in Exhibit 25, there are $218.9 billion in remaining benefits associated with the transportation improvements (in increased economic efficiencies to business, value of business savings, and fuel and time savings) resulting from the expenditure of $66 billion. In other words, discounting the economic impact of the construction activity entirely still results in a benefit/cost ratio of over 3 to 1. (It should also be noted that this report **does not** address the economic losses that will occur if congestion levels are allowed to increase as a result of insufficient infrastructure investment.)

Exhibit 26 shows the net annual impact of savings and benefits in year 25 and beyond resulting from implementation of the TMMP Needs-Based Plan. In total, as a result of $2.65 billion in annual transportation improvements above what is currently expected to be spent, the state will receive an economic benefit of $19.1 billion annually, over a 7-to-1 return ratio.

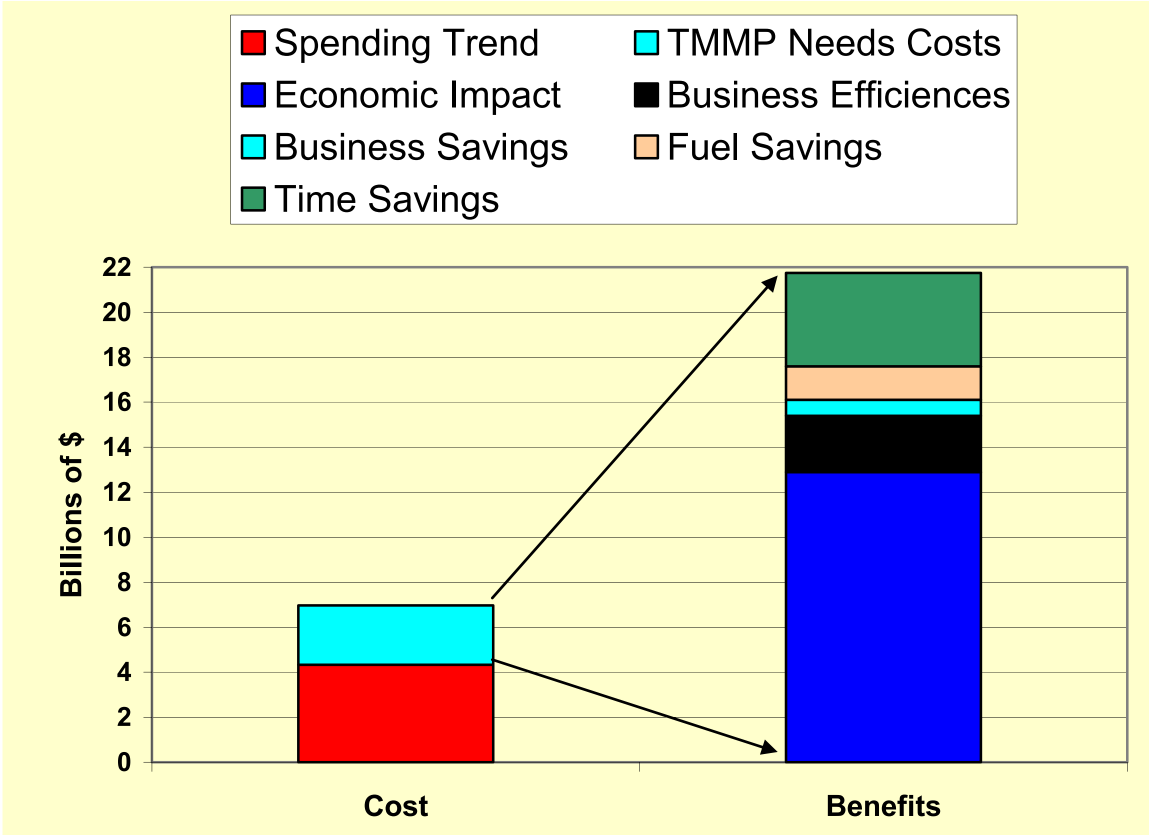
Exhibit 26: Estimated Average Annual Savings and Benefits in Year 25 and Beyond Resulting from Implementing the TMMP Needs-Based Plan

Cost:	Dollars
Annual Cost of Achieving TMMP Needs-Based Plan	$ 2.65 billion
Savings and Benefits:	
Economic Impact of Construction	$ 12.9 billion
Increased Economic Efficiencies to Business	$ 2.5 billion
Economic Impact of Business Savings	$ 0.7 billion
Fuel Savings	$ 1.5 billion
Time Savings	$ 4.1 billion
TOTAL ANNUAL SAVINGS AND BENEFITS	**$ 21.7 billion**
Net Annual Economic Benefit	**$ 19.1 billion**

Note: The Value of Time used in these calculations comes from TTI's Urban Mobility Study and is $13.75 per hour. For the purposes of these calculations, the average price of fuel used was $2.80 per gallon. Due to rounding, numbers may not reconcile precisely to the totals shown in Exhibit 25.

Exhibit 27 shows the same data in another way – as a result of the expenditure of an additional $2.65 billion annually, $21.7 billion is realized through savings and additional economic activity. It is also interesting to note that even without considering the economic impacts, the fuel and time savings alone more than cover the cost of the improvements.

Exhibit 27: Annual Costs versus Benefits of Implementing TMMP Needs-Based Plan



Using the same methodology, when the additional $12 billion in expenditures required in other urban areas ($3 billion) and in rural Texas ($9 billion) are considered, an additional $18.6 billion in economic benefits are likely to be realized over the 25 year period.

Savings at the Household Level

Another way to look at the net new required funding necessary to meet the mobility goals in the TMMP "Needs" versus the benefits received is to examine them on an annual basis in terms of cost per household.

As shown in Exhibit 28 below, if the TMMP "Needs-Based" plan were funded, assuming the state and local split were two-thirds, one-third (as shown in Exhibit 10), the annual cost to a household in the areas included in the TMMP "Needs-Based" Plan would be an estimated $99 per year. Put in terms relative to a gallon of fuel, if the total mobility program cost is approximately 24 cents per gallon in the metropolitan areas included in this study, 13 cents per gallon is returned in the form of fuel savings from improved mobility (based on a fuel price of $2.80 per gallon) making the net cost of the program 11 cents per gallon of fuel.

Exhibit 28: Average Annual New Funding Required Less Fuel Savings – Total and by Household if State Fuel Tax is Indexed to the Rate of Inflation in the Highway Cost Index.

Funding Component	Total in Billions of Dollars	Total Per Household in Dollars	Per Gallon of Fuel in Cents
Estimated New Annual Funding Required (State Share):	$1.78	$152.62	16
Estimated New Annual Funding Required (Local Share):	$0.87	$75.17	8
TOTAL	$2.65	$227.79	24
Estimated Annual Fuel Savings Derived from Improved Mobility:	($1.50)	($128.94)	(13)
New Annual Funding Required Less Fuel Savings from Improved Mobility in TMMP "Needs-Based" Area:	$1.15	$98.85	11

Note: The calculations above do not include time savings as a result of reduced delay or savings to business.

As shown in Exhibit 29 below, if the state fuel tax was tied to the inflationary impact of the Highway Cost Index on both the state and federal fuel taxes, the net cost in actual out-of-pocket expense to a typical household are actually less than the cost of the improvements. (It is important to note that these benefits include only time and fuel savings to individuals and DO NOT include other economic benefits associated with the improvements to mobility.)

Exhibit 29: Average Annual New Funding Required Less Fuel Savings – Total and by Household if State and Federal Fuel Tax is Indexed to the Rate of Inflation in the Highway Cost Index.

Funding Component	Total in Billions of Dollars	Total Per Household in Dollars	Per Gallon of Fuel in Cents
Estimated New Annual Funding Required (State Share):	$1.78	$152.62	8
Estimated New Annual Funding Required (Local Share):	$0.87	$75.17	4
TOTAL	$2.65	$227.79	12
Estimated Annual Fuel Savings Derived from Improved Mobility:	($1.50)	($128.94)	(13)
New Annual Funding Required Less Fuel Savings from Improved Mobility in TMMP "Needs-Based" Area:	$1.15	$98.85	(1)

Note: The calculations above do not include time savings as a result of reduced delay or savings to business.

Notes to Section 1: Assumptions and Methodology Used in Estimating Future Highway Revenues

Assumptions

In any projection procedure, there are a number of assumptions which must be made. Projecting transportation revenues is no exception. The following are the basic assumptions used in calculating projected fuel tax and vehicle registration fees and federal transfer receipts.

1. All fuel tax increases are effective September 1, 2006.

2. Although the model was developed with the capacity to set gasoline and diesel fuel taxes independently, in the attached examples the rates are assumed to be the same.

3. Although the model was developed with the capacity to increase vehicle registration fees on a percentage basis, in the attached examples vehicle registration fees are held constant.

4. No increases in federal motor fuel taxes are assumed.

5. The scenario assuming "$32 billion in state-funded need" assumes an increase in federal reimbursements of $12.2 billion through 2030 as per estimates derived from the analysis of the new federal highway reauthorization act. Other scenarios assume no increase in federal reimbursements.

6. State population increases from 24.3 million in 2006 to 41.1 million in 2030 (the Texas State Data Center 1.0 migration scenario).

7. Miles-per-gallon fuel consumption increases from 19.8 MPG to 23.1 MPG by 2030. The current MPG rate (19.8 MPG) is the average rate for all vehicles currently on the roadways, including commercial trucks.) The projected increase in the MPG average over 25 years is based on the current C.A.F.E. standards (23.8 MPG) versus the C.A.F.E. goal amortized over 25 years.

8. The average annual inflation rate was assumed to be 4.57 percent for the purposes of the annual interest applied to the outstanding spending requirement necessary to achieve the mobility goals (2030 Capacity).

9. Cost estimates developed by TxDOT were used for all costs except those allocated to "2030 Capacity." The "2030 Capacity" costs were calculated as the excess of revenues after subtracting all "non-mobility" costs.

Methodology

1. Annual projections of gasoline tax revenues (Exhibit 30) were developed from historical taxable gallons of gasoline and population data for the period 1972 to 2003. That data yielded a regression model with the following values:

$$y = .5439x - .9188$$

where: y = predicted taxable gallons of gasoline (in millions)
x = projected population (in millions)

$R^2 = .9392$

2. Annual projections of diesel fuel taxable gallons were developed from historical taxable gallons of diesel and population data for the period 1972 to 2003. That data yielded a regression equation with the following values:

$$y = .3567x - 4.6883$$

where: y = predicted taxable gallons of diesel (in millions)
x = projected population (in millions)
$R^2 = .9836$

3. Annual fuel consumption, as measured in taxable gallons, was reduced by the annual percentage increase in fleet-wide miles-per-gallon performance.

4. To project both gasoline and diesel fuel revenues, the assumed tax rate was multiplied by the CAFÉ-adjusted taxable gallons of fuel to yield a total revenue figure for both fuels. Twenty-five percent of that figure was deducted to account for the constitutionally-mandated transfer to public education.

5. Annual projections of vehicle registration fee revenues were developed from historical vehicle registration and population data from 1992 to 2004. A regression model was developed with the following values:

$$y = 50.173x - 317.54$$

where: y = predicted vehicle registration fee revenue (in millions)
x = projected population (in millions)
$R^2 = .9787$

6. Federal reimbursements received on the federal motor fuel tax were assumed to increase by three percent per year from the present through FY2009. From FY2010 forward, federal reimbursements were calculated on the basis on the total taxable gallons of fuel sold multiplied by the current federal tax rate (18.4 cents per gallon). A return rate to Texas of 90 percent was assumed on that amount. The change in methodology from FY2009 to FY2010 was assumed because, at present rates, the increase in federal transfers resulting from the recent federal highway reauthorization bill will likely cause a spend-down of the highway account of the highway trust fund such that annual disbursements will be limited to annual receipts by FY2010. Future highway reauthorization bills may alter this scenario, but that cannot be assumed at present.

7. Projections of the annual rate of increase in the Highway Cost Index (HCI) (Exhibit 31) were developed from historical HCI and CPI data from 1992 to 2004. That data yielded a regression equation with the following values:

$$y = .9449x - 19.888$$

where: y = predicted HCI

x = projected CPI

R^2 = .8432

Exhibit 30: Fundamental Assumption and Projections

Year	Projected Population	Taxable Gallons of Gasoline	Taxable Gallons of Diesel	Per Capita Gasoline Consumption	Per Capita Diesel Consumption
2005	23,276,617	11,239,270,000	3,521,610,000	482.9	151.3
2006	23,805,220	11,512,362,113	3,839,760,192	483.6	161.3
2007	24,347,034	12,239,154,135	3,905,330,328	502.7	160.4
2008	24,902,640	12,539,866,808	4,098,752,693	503.6	164.6
2009	25,473,227	12,848,692,616	4,297,229,965	504.4	168.7
2010	26,058,593	13,165,523,132	4,500,937,440	505.2	172.7
2011	26,659,092	13,490,550,287	4,709,902,151	506.0	176.7
2012	27,275,208	13,824,036,263	4,924,269,965	506.8	180.5
2013	27,906,502	14,165,744,555	5,144,067,070	507.6	184.3
2014	28,553,041	14,515,712,013	5,369,224,969	508.4	188.0
2015	29,213,821	14,873,396,743	5,599,612,650	509.1	191.7
2016	29,889,139	15,238,959,789	5,835,078,097	509.8	195.2
2017	30,578,882	15,612,340,642	6,075,668,828	510.6	198.7
2018	31,283,074	15,993,552,805	6,321,368,208	511.3	202.1
2019	32,002,395	16,382,964,312	6,572,275,140	511.9	205.4
2020	32,736,685	16,780,489,239	6,828,516,872	512.6	208.6
2021	33,488,539	17,187,530,716	7,090,391,015	513.2	211.7
2022	34,258,650	17,604,464,005	7,358,558,167	513.9	214.8
2023	35,047,399	18,031,495,759	7,633,223,296	514.5	217.8
2024	35,855,269	18,468,887,783	7,914,533,730	515.1	220.7
2025	36,682,181	18,916,598,097	8,202,595,850	515.7	223.6
2026	37,528,707	19,374,936,628	8,497,458,980	516.3	226.4
2027	38,395,256	19,844,125,212	8,799,306,862	516.8	229.2
2028	39,281,941	20,324,225,668	9,108,253,520	517.4	231.9
2029	40,189,407	20,815,587,440	9,424,396,680	517.9	234.5
2030	41,117,590	21,318,176,659	9,747,892,344	518.5	237.1

8. One set of assumptions relative to fuel tax revenue allows the state gasoline and diesel fuel tax rates to rise by the amount of increase of the Highway Cost Index as explained in number 7 above. Another set of assumptions allows both the state and federal gasoline and diesel fuel tax rates to rise by an amount equal to the amount of annual increase in the Highway Cost Index. (In the latter case, the state tax is raised by the amount that the federal tax would have increased if it were tied to the Highway Cost Index.)

Exhibit 31: Projections of Percent Increase in Highway Cost Index

Year	Projected Highway Cost Index
2005	
2006	
2007	2.35%
2008	2.24%
2009	2.25%
2010	3.00%
2011	3.07%
2012	3.03%
2013	2.89%
2014	2.81%
2015	3.20%
2016	3.41%
2017	3.60%
2018	3.73%
2019	3.80%
2020	3.81%
2021	3.82%
2022	3.90%
2023	3.86%
2024	3.85%
2025	3.83%
2026	3.82%
2027	3.83%
2028	3.74%
2029	3.75%
2030	3.70%

SECTION II
Pay-As-You Go Versus Financing Roadway Improvements

Another issue that should be addressed is the utility of accelerating construction projects by financing roadway improvements through bonds or other similar means.

The Necessity to Address Accumulated Investment Needs

As states and metropolitan areas consider the daunting transportation investment needs facing them it is increasingly clear that there is a substantial gulf between their investment needs and their resources. Many states have seen resistance to increasing fuel user charges, their main source of revenue, even as needs continue to increase. Needed projects are scheduled off into the distant future because of lack of resources as cost inflation serves to make those postponed projects even less financially accessible over time.

In this environment there are multiple forces at work on program planning:

1. increasing costs over time from inflation

2. increased costs as projects move forward in fits and starts and small pieces

3. reduced benefits to users from the deferral of new facilities

4. increased costs to users from congestion and lack of reliability

At the national level similar issues apply as costs escalate and investment opportunities for increased benefits or reduced costs are foregone due to lack of resources.

One way to better visualize these conditions is shown in Exhibit 32. That figure envisions a perfect system with no capacity problems and no physical condition problems, no deficient bridges or structures, etc. In that perfect system future costs would be a function of the actions of time. That would include:

1. the actions of weather on the facility over time

2. the actions of wear and tear as the facility is used over time

3. the actions to respond to travel growth over time as new population and industry evolves.

One could readily foresee that in this situation additional funds would be needed during future years. The reasons for the cost increases would be clear and the public would likely understand the necessity of addressing those costs. One could readily see a taxing mechanism to support the relatively steady-state system of needs shown in the figure.

Exhibit 32: The "Perfect" System of System Maintenance and Expansion

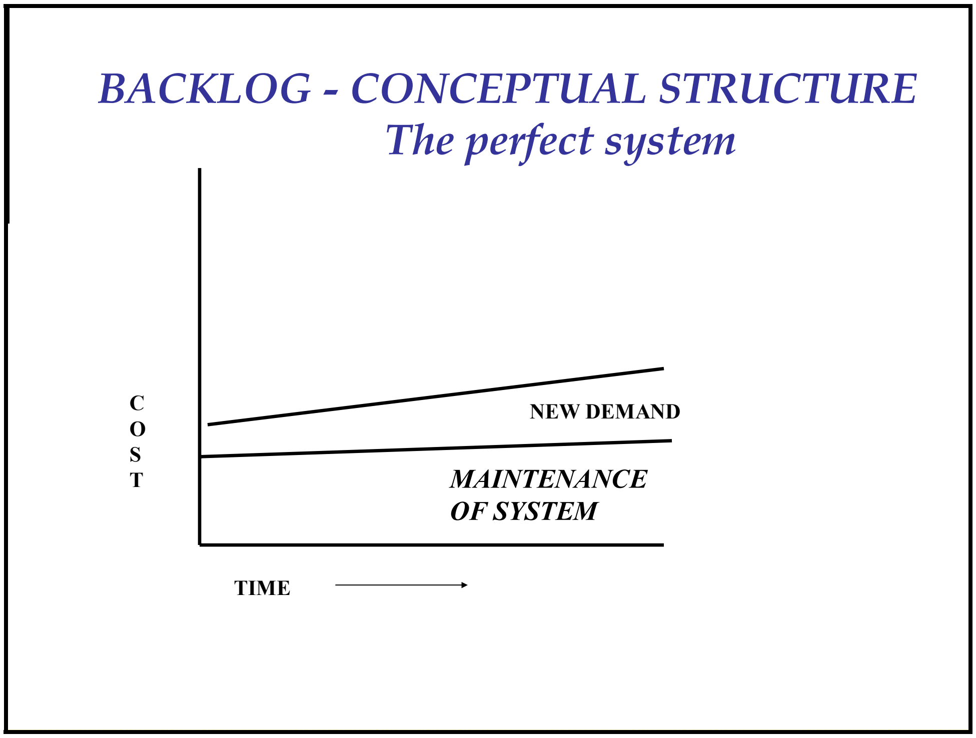
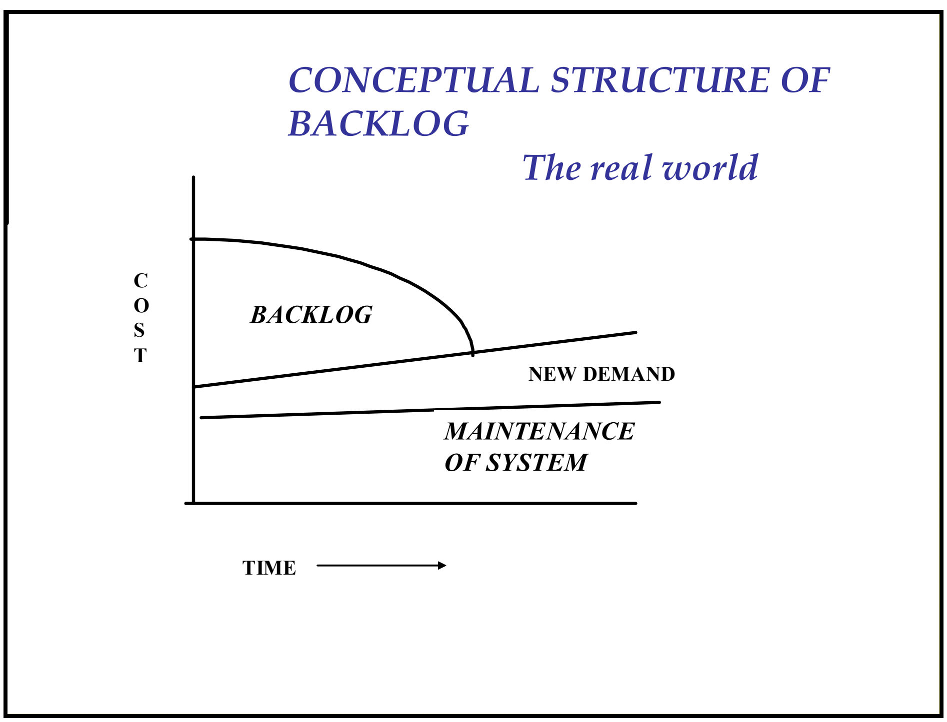


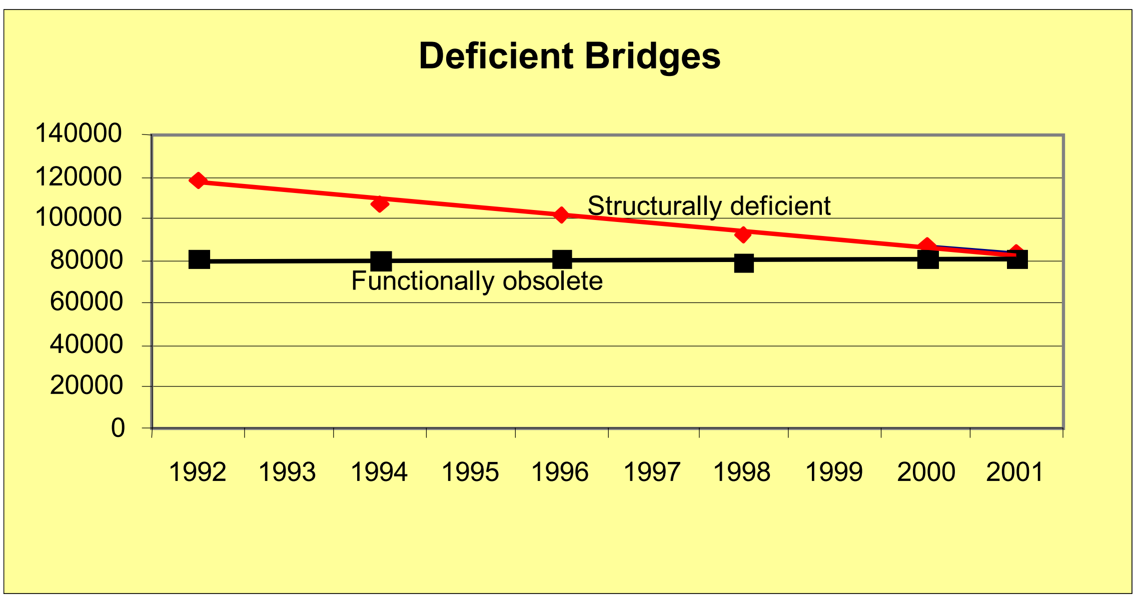
Exhibit 33: The "Real-World" System of System Maintenance and Expansion



But our highway systems are not perfect! They are burdened with bridge and road condition problems and with capacity deficiencies. They are far from adequate in either engineering or economic performance perspectives. These problems are called a backlog because there is no further action of time needed for them to develop into investment needs. They are needs today. They were needs yesterday. It is the failure of adequate resources that causes this backlog to exist and to grow. The set of investment needs into the future looks like Exhibit 33 which shows the impact of the backlog. For purposes of gaining a sense of scale, the national backlog estimated by AASHTO as part of the present reauthorization analyses was approximately equal to 4 years of the total capital program. It would be safe to estimate that Texas's backlog is at least similar in scale. Given Texas's growth rate in population and travel it could be greater than the national average.

The benefits of spending down the backlog can be seen most clearly in the trend shown in Exhibit 34. Here the national backlog of bridge condition was staggering in 1992, with 120,000 structurally deficient bridges and 80,000 functionally obsolete bridges out of about 580,000.[1] Using the additional funds made available in ISTEA and TEA-21, the structurally deficient bridges were attacked and in less than ten years brought down to the same level as the functionally obsolete facilities. Funding proposed in the early discussions for the current reauthorization would have been adequate to continue to maintain bridges as needed and to continue to reduce the backlog as well. It is unclear at this point whether such funding will be available. The key point is that one-third of structurally deficient bridges were addressed and resolved in less than ten years.

Exhibit 34: Number of Bridges in the U.S.



[1] A structurally deficient bridge is one that cannot safely or effectively handle the loads expected of it. In the absence of action it may need to have load limits set on it, have certain types of vehicles banned, or even be closed. A functionally obsolete bridge is one that no longer is consistent in its service characteristics with the road it is a part of. It may lack the height or width requirements, or the curvatures may be inappropriate. A simple example is a two-lane bridge connected to a four-lane road.

A critical national question, one echoed in Texas as well as in other states, is that, given the kind of backlog we face and the benefits foregone from not relieving the backlog, how rapidly can we or should we try to reduce that backlog? For every year the backlog persists, benefits are foregone; for every year the backlog persists, costs rise from inflation and from the more rapid deterioration of the system left unattended. Fatalities occur; accidents occur. Fuel and time are wasted.

At the same time there are costs to attacking the backlog. These include the costs of borrowed money or diverted resources to fund an accelerated program as well as the dislocations from a program that does not have a consistent budget, but has a rapid increase of program funding in the near-term likely followed by a tapering off (similar to the graph in Exhibit 36). The computer models simulating the best approach to dealing with the national backlog estimated that instead of the first five years of a twenty year national program containing a proportionate share of dollars, where each year represented 5 percent of the total, the preferred program that maximized benefits expended 40 percent of the program rather than 25 percent. This is equivalent to running eight years of the twenty year program in the first five years. There is perhaps no perfect answer to how fast the backlog should be spent down. Again, given the capacity needs in Texas, the percentage could be higher. This section will review some of the elements involved in the decision process in order to help organize thinking about when trade-offs need to be assessed.

The Pay-Offs from an Accelerated Program

There are fundamentally four kinds of pay-offs of accelerating a highway program:

1. cost growth effects of inflation are reduced

2. the benefits of the project are brought on-stream sooner

3. other beneficial projects are brought forward into the project stream

4. there are often logistical benefits to contractors working faster in larger undertakings

Inflation

Many projects that are deemed acceptable begin to lose acceptability over time as inflation increases their costs. Often, highway revenues are fixed and are not sensitive to inflation and purchasing power is badly eroded by inflation. Jurisdictions may only have a set amount of money and when inflation effects raise the cost beyond that level, the undertaking may need to be postponed. Road construction costs will often track with the Consumer Price Index, with which most people are familiar, but in certain periods it may lag or lead the CPI significantly. The Engineering News Record index of construction costs, after peaking at a 4.5 percent increase in 1993 over 1992, has not risen above 3 percent in the last decade, but, even so, the 10 year increase is 24 percent. Often delaying tactics are one of the strategies used by opponents to projects hoping that inflation will eventually destroy the viability of the undertaking.

When private firms are developing roads, then inflation costs may be the key to success or failure of the project. Their investment strategies may depend on continued short term limited inflation or to a rapid development of revenue streams to support costs. The uncertainties of present development of needed facilities with long lead times and unclear conclusions often defer private initiatives.

Early Benefits

Many projects have important streams of benefits associated with their development such as safety improvements. These are always such that they justify the costs of investment to the users. Modern economic analysis recognizes that a dollars worth of benefit today is more valuable than the same dollar of benefit next year and even more than the year after that, etc. Benefit/cost analysis will reduce future benefits often based on present expected rates of return estimated. But beyond the analytical aspects, the public has its own very valid understanding of these terms. An improved road this year means one year less of sitting in congestion; a safer road means one year sooner of fewer accidents or fatalities than under the old structure.

Again, when private road builders are investing, the greater the speed with which they can open a road and gain income (usually from tolls) the more likely their venture will be a financial success. The construction years where costs are incurred and interest payments are borne without a revenue stream are often critical periods regarding potential success.

Beneficial Projects are Brought Forward

This is often an overlooked benefit of accelerated programs. When projects are accelerated, it not only means that the selected project moves faster and cheaper and benefits are obtained earlier, but it also means that all of the other beneficial projects lined up in a queue waiting their turn for action are moved forward. From a political point of view it means that the sooner the project in this part of the jurisdiction is completed, the earlier work can move on to delivering beneficial projects to other parts of the jurisdiction ensuring a sense of program equity.

Logistical Benefits

When projects are undertaken with the very beneficial pressures of time in mind given the aspects identified above, then the option exists for larger task undertakings to be developed, perhaps with considerable savings. These savings may take the form of administrative overhead savings in bidding, design and planning, reduced costs of setting up and taking down a project, or benefits of scale in labor or materials. Any activity that contributes to reductions in delay of work is an important cost-reduction tool. This will be discussed later as a separate topic.

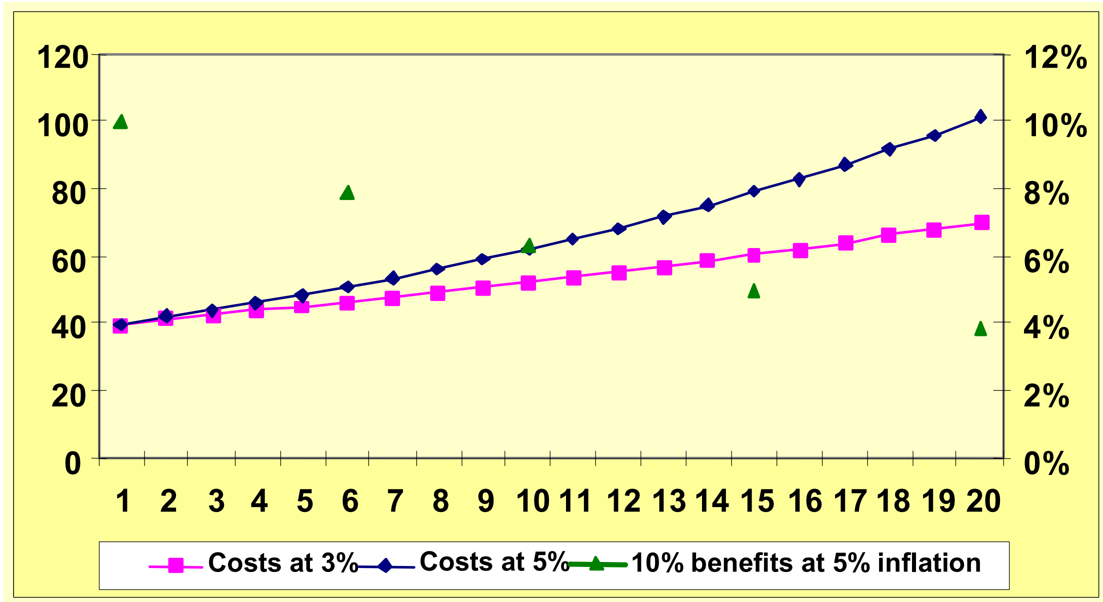
Ways to Accelerate the Program

There are fundamentally two ways to accelerate a program. The first is by increased resources made available to the public agency charged with the task. This may be a product of new funds generated via new or increased fuel-based user fees or other levees. Often today it is the result of funds moved forward in time by bonding that provide loans to use today to be paid off tomorrow with future fixed revenues. In other cases it will involve new sources of revenue based on tolling systems applied to specific facilities. The second way to accelerate programs is by the expanded participation of private operators that often will also take the form of toll-based facilities. This may involve their sole proprietorship of road facilities usually extracting a fee in the form of tolls on the facility of interest or via public/private partnerships that involve some degree of shared responsibility for an undertaking.

There are sets of forces at work that often conspire to reduce support for increased fuel user charges not least the public's reluctance to be taxed in general. Bonding within a fixed revenue base does not create new money for the overall highway program; it simply shifts money forward in time – at a cost. That cost is interest which may effectively reduce the total overall long-term program. Whether it is worth it to move projects forward given the prospective costs involved will be a product of the interplay of the forces described above. When, for example, construction inflation rates are higher than interest rates for borrowing, it is clear that the earlier building of projects is highly desirable and benefits will be at least the difference between the inflation cost and the interest cost, with the added value of early benefit streams. When interest costs are greater than construction costs, a closer analysis is required but may still be highly desirable.

Exhibit 35 below depicts several examples of the effects of elements of the foregoing discussion. First, a program in which $39.9 billion is to be financed will have grown to almost $62 billion in costs if inflation is reckoned at 5 percent, or $52 billion at 3 percent, if the program is delayed ten years. By that reckoning, benefits are also reduced to a range of 6 percent to 7 percent from their original 10 percent, estimated for purposes of this example. Another way to visualize this effect is that early program development in year one would save between $12 billion and $22 billion in program investment costs due to inflation as opposed to building the project in year 10, and in addition would yield an earlier benefits stream and move other beneficial programs closer in the queue. These benefits from earlier development offset the prospective interest costs generated by earlier program development.

Exhibit 35: Impact of Inflation at Selected Rates on Construction



Bonding based on future revenues is simply an example of the tradeoff of a total program with earlier benefits versus a larger program with later benefits (the difference in program scale being the cost of interest). The example is provided below of the state of Alaska where these trade-offs are explicitly addressed.

Bonding based on tolling is an example of accelerated benefits but with enhanced revenues so that there is a net increase in the total scale of the program.

It is often argued that private firms will be able to perform needed construction and related pre-construction activities such as environmental reviews faster or cheaper than public agencies. In some cases this has been borne out, but it is inappropriate to assume that private approaches will always be more efficient than public. There are examples of efficiencies and inefficiencies on both sides. The more important point is to realistically assess the incentives on either side. In some cases public agencies will have little incentive to accelerate a program where private investors will have massive incentives for rapid action.

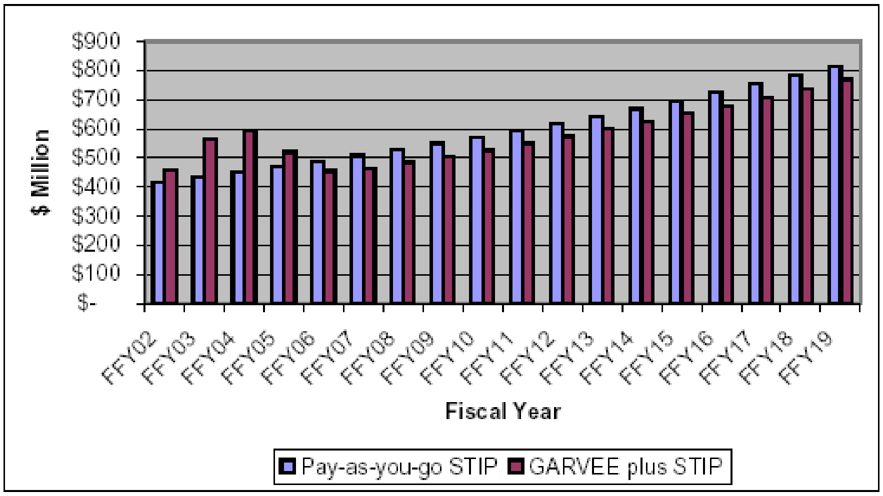
The Example of Alaska

Alaska viewed its total program as a constant over an estimated 15-20 year life of bonds, and therefore the set of prospective benefits, of the types identified above, had to be weighed against an overall smaller program (in that interest paid to bring funding forward reduced the total program possible). The graphic below, reproduced from their Benefit/Cost Study, shows that in a total federal-aid capital program of $2,062 million over the first five years, large parts of the program could be brought forward with important projects undertaken and completed earlier by the use of GARVEE bonds. (Garvee's basically are a new financial vehicle that permits states to borrow against anticipated future federal funds.) In this case a substantial shift in program occurred, bringing forward $325 million in program funds, as shown in the figure, at a total program cost of $58 million in interest. Their total program for the period was able to be $2,593 million instead of $2,267 million on a pay-as-you-go basis. Inflation cost savings for the period amounted to over $39 million. In regard to the potential overheating effects of a ramped-up program, they found that the Alaskan construction industry could absorb the increment without significant cost impacts.

In effect, then, their total eighteen-year program was reduced by $58 million for the period. Their analysis showed that regardless of the assumptions used, the GARVEE approach provided a higher benefit/cost ratio and was very much worth doing. The economic benefits averaged two percent higher; transportation benefits eight percent higher; and costs to the state averaged eight percent lower. Because of special attributes of the GARVEE's and the particulars of Alaska, savings in interest also occurred. In effect the increased program occurred with a net decrease in state-only funds.

Exhibit 36: Alaska Case Study

Figure 1 Comparison of STIP and GARVEE Bond Construction funding



The following two charts show the relative proportion of funding for projects during the next five years under the two cash flow plans:

Figure 2 STIP Project Funding Sources FFY03-07

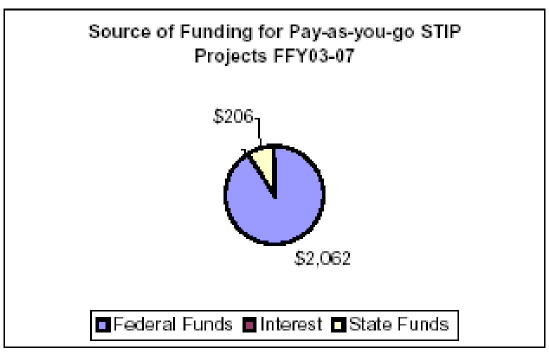
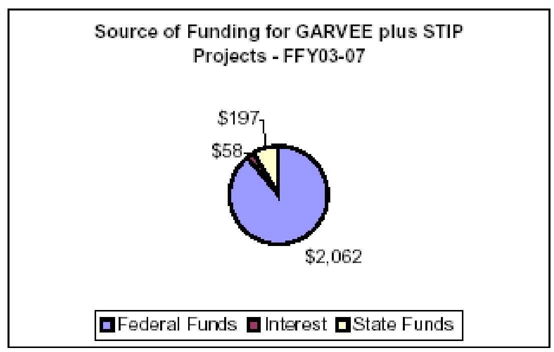


Figure 3 GARVEE Funding Sources FFY03-07



The GARVEE approach saves the state $11 million in state general funds during the next five federal fiscal years, while building an additional $325 million in highway projects during the same period.

Other State Programs

The TIMED program (Transportation Infrastructure Model for Economic Development) Program in Louisiana is the largest transportation program undertaken in that state's history. The $3.8 billion improvement program includes widening 500 miles of state highways to four lanes in 11 project corridors, and also includes major bridge and sea and airport improvements. It is designed specifically to enhance economic development in Louisiana through investment in transportation projects. The state DOT is also the state agency for economic development. This program clearly occurred prior to the recent devastation in the state as a result of the Katrina hurricane. Based on Katrina's effects, priorities have been revised.

An ad-hoc 4 cent per gallon gas tax increase was intended to fund the program through its life. Employing this pay-as-you-go financing, it was recognized that the entire effort would take 30 years. A bonding undertaking, starting in 2002, and extending to 2008, will permit completion of the total program in 10 years rather than 30.

New Mexico has accelerated its development plans with a bonding program to assist state needs in highways and transit which will move forward benefits unachievable except in the very long term.

The South Carolina Department of Transportation is accomplishing 27 years of road and bridge projects in just 7 years by establishing a financing package that put together a $5 billion program of advanced road construction. The state indicates that it is fifth lowest in fuel taxes among states and many of these projects had been waiting for funding as long as 30 years ago. A major goal was to address severe safety issues.

Private Sector Approaches

The Alaskan and other state examples above are typical of the kinds of rewards seen from an internal shift of finances within a state agency. As effective as these approaches might be, they still often fail to meet the needs of the future. States increasingly are open to private sector participation in the development of roads, as partners or as sole operators. Part of this stems from the fact that many states have increasingly found it politically difficult to raise gas taxes to fund expanding program needs. More and more states seem to see private or public-private toll-based alternatives as the major opportunity for expansion. One important way to consider it is that even if the state is prepared to finance the entire program at appropriate levels, a new source of building with separate financial capabilities is welcome. An important distinction within the category of private sector approaches is that between non-profit and profit oriented private undertakings. Most private profit operations are generally of an "arms-length" nature between government and the operator, whereas non-profit private operations will often receive state assistance in their undertaking in the form of right-of-way, assistance with planning and design, or access to loans.

Many states also see the concept of tolling as providing an appropriate second tier of their service system, not as a replacement for fuel tax-based systems, in that basic transportation services are paid for out of tax revenues or other public funding; the second tier of services, providing premium services to users, is most appropriately provided at extra user cost, via tolls. Many users may also see this approach as beneficial in that they are charged a fee only when they use the facility and have no other financial responsibility for roads that others use. In effect, they are free to opt in or opt out of using the service. This may be particularly significant to truckers who must always be highly sensitive to costs.

Although discussed here as part of private sector approaches, the use of tolls is, of course, not limited to private providers. Many states have had public entities providing toll services for many years, predating the Interstate system, but as states consider the idea of tolling today it is often considered in the light of an opportunity for new institutional arrangements, often involving private players, to undertake the expanded services. One reason for this is to take advantage of innovative contracting methods, which, in combination with private initiatives and resources, can make a major addition to overall programs.

For some of the items discussed here in regard to time and money savings opportunities in the private sector, it may be difficult to distinguish the source of the benefits as between public versus private institutions in contrast to new methods of contracting and financing projects. An additional point often raised re private initiatives is that the private sector funding even where it involves bonded indebtedness does not encroach on the state's bonding ceilings. It is additive; where less successful programs might occur, the state's bond ratings are not affected. The very flexibility embodied in some of these new so-called innovative finance and innovative contracting approaches indicates something important about the value of greater private sector involvement and greater state interest in being more open to new approaches. It is important to recognize that it requires innovative public agencies as well as private participants. It is a new way of doing business on both sides.

Much of what is happening is relatively new and still uncertain in all of the effects engendered. Only a limited number of studies have been conducted monitoring these patterns (many private actors see much of the material as proprietary and prefer not to discuss or publish plans and methods). Within that framework there is still significant evidence of cost and time savings that encourage further use of the new methods. For example:

- The state of Virginia has led in many of these areas. Their Virginia Public-Private Transportation Act in 1995, VPPTA, permitted unsolicited private proposals and opened the door to many new ideas and projects. The first project under the new act, the Pocahontas toll Parkway, came in $10 million under the $324 million estimated cost. Another project, a belt road around the western edge of the state capitol came in at a savings of $47 million over the state estimate of $283 million and a time savings of more than three years over the original plan.

- A US GAO study found that transportation projects that involved private investment were built sooner than they would have been if the private sector were not involved.[2]

- The state of Florida, in a comparison of innovative approaches, found that traditional low-bid approaches had an average of 12.4 percent overruns whereas of 56 new private-based approaches had overruns that averaged less than 4 percent. Similarly, traditional approaches yielded over 30 percent time overruns contrasted to about 7 percent for the innovative approaches. Many of these approaches make use of incentives that penalize lateness and reward early completions.

- A Battelle study conducted for Koch Industries documented cost savings in a range of 6 percent to 40 percent for private-based approaches.[3]

- The Denver E470 47 mile Toll Road using Design-Build concepts, which permitted larger contract approaches with a single source of responsibility, was constructed at a cost of $408 million which had been estimated at $597 million under traditional approaches. The entire effort took 3 years from notice to proceed to opening.

- The South Carolina Southern Connector Toll Road developed under a Design-Build-Finance-Operate approach was completed 9 months early.

- Two Orange County California Toll undertakings were both completed 10 months ahead of schedule.

All of these projects refer to new facility construction activities, but many new innovative approaches to maintenance demonstrate similar savings. Often the construction projects are designed with guarantees built in for contractor maintenance of the facility.

<u>Applications to Texas</u>

A number of issues arise when consideration is given to applying some of these innovations to the Texas environment.

- There is an inherent conflict over who will get the prime facilities that would yield major payoffs. For example, the public sector chooses to invest money in those areas where congestion is most acute, and the returns as a result of relieving that congestion are the greatest. That is a rational decision from a public policy point of view. However, as a result, projects often left as candidates for public/private or wholly private ventures often have more marginal returns. Consequently, it may be the case that some form of subsidy remains as a policy

[2] US GAO; *Highways and Transit; Private Sector Sponsorship and Investment has been Limited*, March 2004.
[3] *Performance-based contracting for the Highway Construction Industry*, Battelle, Feb. 2003

option in order to make private investment in more marginal project financially attractive.

- The Texas backlog of investment needs in highways needs to be identified. The scale of the backlog relative to emerging future needs will define the overall scale of the program and to a significant degree the timing. The benefits of acceleration of the program will largely be a product of serving current needs rather than future needs. The present levels of the TCI throughout the state shown in Section 1 are an implicit indicator of the massive backlog of system performance needs. The number of bridges in the state identified as of 2004 as Structurally Deficient were 2,580; another 7,615 were identified as Functionally Obsolete. Thus a total of 10,195 bridges were labeled as deficient out of a total of under 50,000 bridges in the state, for more than 20 percent of all bridges as deficient. This is a strong indicator of critical backlog in terms of safety and performance.

SECTION III
Accelerated Construction: A Case Study of the Katy Freeway

The Katy Freeway expansion project is being constructed using an innovative combination of construction and financing techniques. This section analyzes the effect of the shortened construction schedule on the travel delay and the cost effectiveness of the more rapid construction effort. The project, in broad terms, results in a six-year construction program, (compared to the 12-year original schedule), provides a four-lane tollway in the middle of an expanded freeway, improves the aesthetic and landscaping treatments in the corridor and rebuilds the existing freeway pavement and bridges.

Background

The Katy Freeway (I-10) extends 40 miles from the Central Business District of Houston west to the Brazos River. Constructed from 1960 to 1968 with 6 to 10 lanes, it was designed to carry 80,000 to 120,000 vehicles per day and to have a pavement life of 20 years before major reconstruction would be required. A single-direction HOV lane has since been added in some portions of the corridor for buses, vanpools and carpools.

Today, the Katy Freeway carries 200,000 to 250,000 vehicles per day including 16,000 heavy-duty trucks. The freeway is congested for up to 11 hours each day, not just during conventional peak hours. Furthermore, maintenance costs are reported to be in the range of $200,000 per mile (almost $8 million per year), about four times the normal maintenance costs. In addition, the Katy Freeway does not meet current TxDOT and AASHTO design standards. Since 1994, the Katy Freeway has experienced an accident rate 33 percent higher than the statewide average for similar roadways.

The Project

The Texas Department of Transportation, after more than 15 years of discussion, planning, and public meetings with businesses, community members and elected officials, has developed a plan, with widespread business and community support, to address the need for an improved Katy Freeway.

The Katy Freeway reconstruction program encompasses the eastern 20-mile section from its intersection with I-610 West Loop to the City of Katy. The freeway will have 14 lanes: 4 managed toll lanes, 8 general-purpose lanes and 2 auxiliary lanes. The toll lanes will be separated on each side from the other lanes by a two-foot buffer, have 5 access points including the western and eastern ends and will operate exclusively with the EZ Tag system. The buses and carpools will use the toll lanes.

The Federal Highway Administration issued a Record of Decision for the project in August of 2002 for tolled managed-use lanes in the center of the reconstructed Katy Freeway as part of the Value Pricing Pilot Program currently in operation on the Katy Freeway HOV lane. In March 2003, Congressman John Culberson and Texas

Transportation Commission Chairman Johnny Johnson announced that the Commission was set to approve an agreement with Harris County to improve the Katy Freeway. The agreement would implement the tolled managed-use lanes in the center of the freeway, and, in exchange, the Harris County Toll Road Authority (HCTRA) would purchase the operating franchise for the four tolled lanes for $237 million and another $250 million in in-kind services should they be needed. This funding would accelerate the Katy Freeway expansion project and allow construction time to be cut in half from twelve to six years. Additionally, the Toll Road Authority agreed to provide a no-interest loan for up to $250 million with a repayment period of 15 years.

Without this unique funding arrangement the project, begun in 2003, would be completed in 2015. With the participation of these entities and acceleration in available funds, the project will be substantially completed by the end of 2008.

Project Scope

The Katy Freeway construction project takes place on a freeway with intense existing congestion. This congestion will worsen over the next 10 to 20 years if the expected home, commercial and office development occurs. The more rapid completion of the construction project may result in the following effects:

- Fewer years of construction-related effects on businesses and travelers in the corridor;
- Increased delay each year of the construction program due to more lane closures, more narrow lanes, greater effect of collisions and vehicle breakdowns on the narrowed roadways; and,
- Approximately the same conditions in 2015 under either construction program.

For the purposes of this analysis, the same amount and type of land development is projected. A longer construction program may cause some office, shop or home development to locate in other corridors. This would result in slightly lower 2015 congestion levels under the longer construction program, but more significant business costs due to loss of development and reduced land value. In addition, the congestion levels in the corridors with the relocated development would increase.

The first two factors are estimated in this paper. Traffic speeds on the major corridor sections have either continued to decline steadily—following the pattern since 1997—or slightly improved. The economic slowdown during 2002 and 2003 caused slight general improvement in speeds in some parts of the Houston area.

While the construction contract has incentive-disincentive clauses that result in few lane or roadway closures and maintain the previously existing number of through-lanes during peak periods, this is a large construction project in an intensely developed, high traffic area. There will probably be more delay during each year of the rapid construction schedule than during a year of the traditional schedule, but in most cases, the lane and roadway closures are caused by overhead or underground construction that is required by the final road design, not the method or timing of construction.

The most conservative estimate of the benefits from a rapid construction program includes an assumption that conditions after 2015 are similar under either construction phasing scenario. Some reduction in development would occur if road construction took a dozen years to complete, but if that development occurred at some other location, it would cause congestion. Given the complexity of identifying where, how much and what type of development might occur, therefore, this analysis assumes no change in development and no difference in conditions after the traditional construction approach would complete the project in 2015.

Congestion Levels

The speeds projected for 2009 and 2015 were based on the trend experienced on Katy Freeway since 1997 (see Exhibits 37 through 39) and estimates of the effect the widened freeway would have. The 2009 opening of the freeway main lanes and managed lanes will see a significant improvement in conditions. The peak hours will remain congested, but the peak-period congestion will exist for fewer hours, and midday and weekend congestion should be much less frequent. Two key assumptions were made to study the cost effectiveness of the rapid construction process. Further investigation of these should be done, and there are more detailed computer models that can provide improved estimates. These estimates will likely require a more specific set of operating practices, policies and projections, particularly as it relates to the managed lane tolls.

- Similar bottleneck patterns will exist in the future. I-610 acts as a restriction on the volume on I-10 between the Loop and downtown. Improvements to I-10 through the I-610/I-10 interchange and improvements to I-610 may increase capacity enough to allow more vehicles on I-10, assuming there are more vehicles that wish to use that section of freeway. The additional volume that will be served and congestion this might cause is not factored into the estimates.

- Volume on the managed lanes will be determined by the mainlane freeway travel times and the toll rates for trips on the managed lanes. Without a detailed set of toll and volume estimates, this paper included several assumptions to develop a rough estimate of the mix of traffic for the daytime and nighttime analysis periods. One key policy-level assumption for the benefit analysis is that the managed lane prices would be set to provide free-flow service during all operating periods. This will limit the number of persons in the lanes but will also mean there is no delay to managed lane travelers. Alternative scenarios can be studied.

Exhibit 37: Katy Freeway Average Daytime Speeds

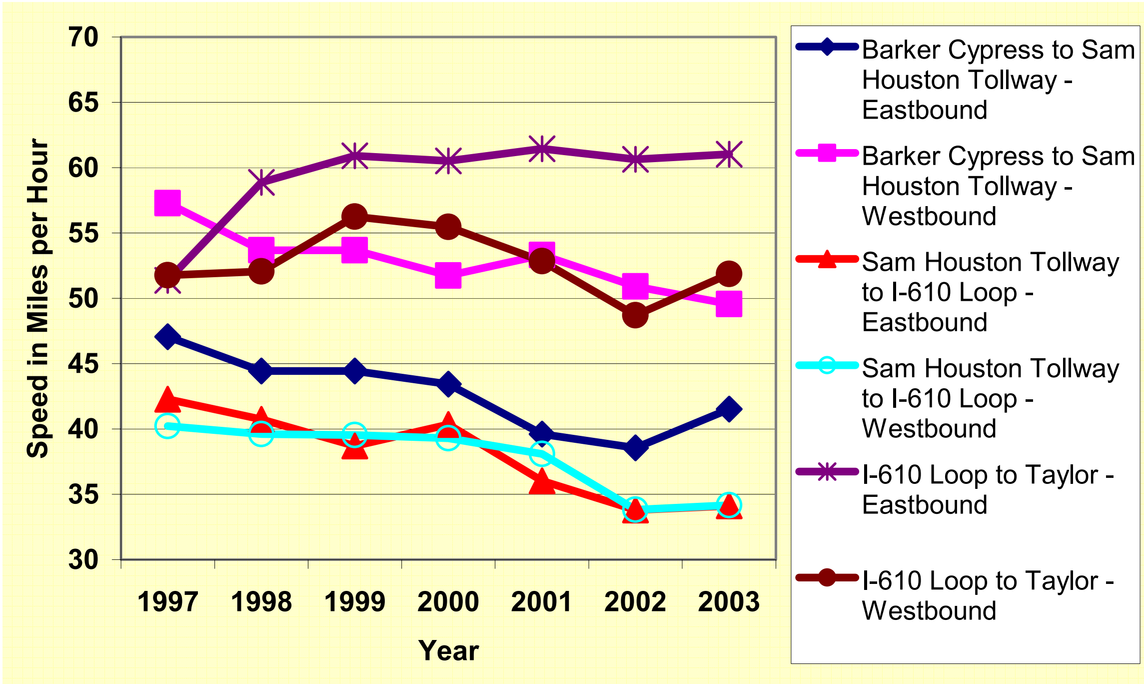


Exhibit 38: Katy Freeway Average Nighttime Speeds

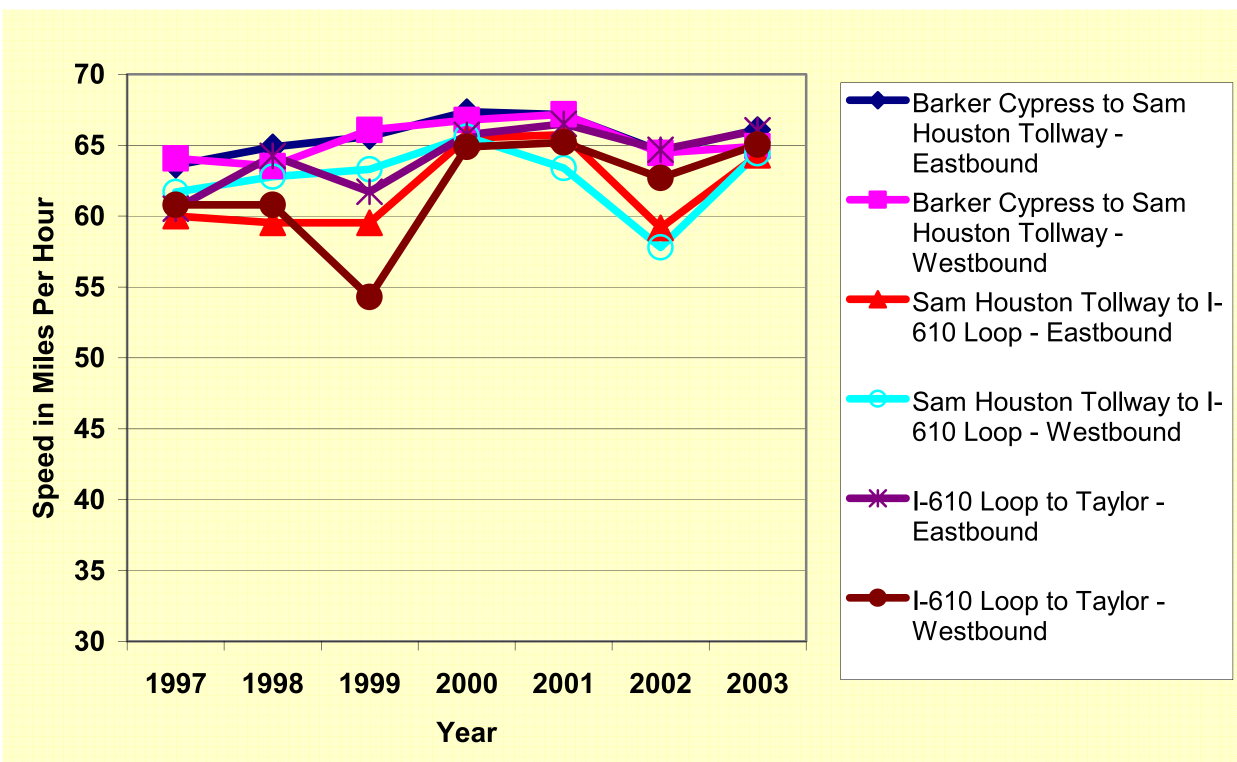


Exhibit 39: Estimated Daytime (6 a.m. to 8 p.m.) Travel Speeds (mph)

Section	Katy Corridor Section	Rapid Construction Program			Traditional Construction Program		
		2003	2009	2015	2003	2009	2015
1	Katy to Barker-Cypress						
	Mainlane	50	55	52	50	47	52
	Managed Lanes	NA	60	60	NA	NA	60
2	Barker Cypress to Sam Houston Tollway						
	Mainlane	43	50	45	43	36	45
	Managed Lanes	60	60	60	60	60	60
3	Sam Houston Tollway to I-610						
	Mainlane	35	50	45	35	29	45
	Managed Lanes	55	60	60	55	53	60
4	I-610 to Downtown						
	Mainlane	55	55	53	55	52	53
	Managed Lanes	NA	60	60	NA	NA	60

Exhibit 40 illustrates the traffic volume growth rates for each segment of Katy Freeway. A diverted demand factor was also used to increase the volume estimates for traffic that is using parallel routes. This traffic would shift to the new Katy Freeway mainlanes or managed lanes from parallel arterial streets due to the decrease in congestion levels after construction is complete.

Exhibit 40: Katy Corridor Traffic Growth Rates

Katy Corridor Section	Annual Average Growth Rate			Diverted Demand Factor
	1995 to 2003	2003 to 2009	2009 to 2015	
Katy to Barker-Cypress	5.4%	3.0%	3.0%	0%
Marker Cypress to Sam Houston Tollway	4.2%	2.5%	2.0%	10%
Sam Houston Tollway to I-610	2.2%	2.0%	1.5%	10%
I-610 to Downtown	3.5%	1.5%	1.0%	5%

Note: "Diverted Demand Factor" is the percent of total daily volume on the Katy Freeway that had been diverted to other roadways as a result of congestion

Exhibit 41 presents the resulting delay calculations from the speed and volume estimates. Delay decreases sharply in the post-construction period but begins rising afterwards as the development and traffic growth occurs.

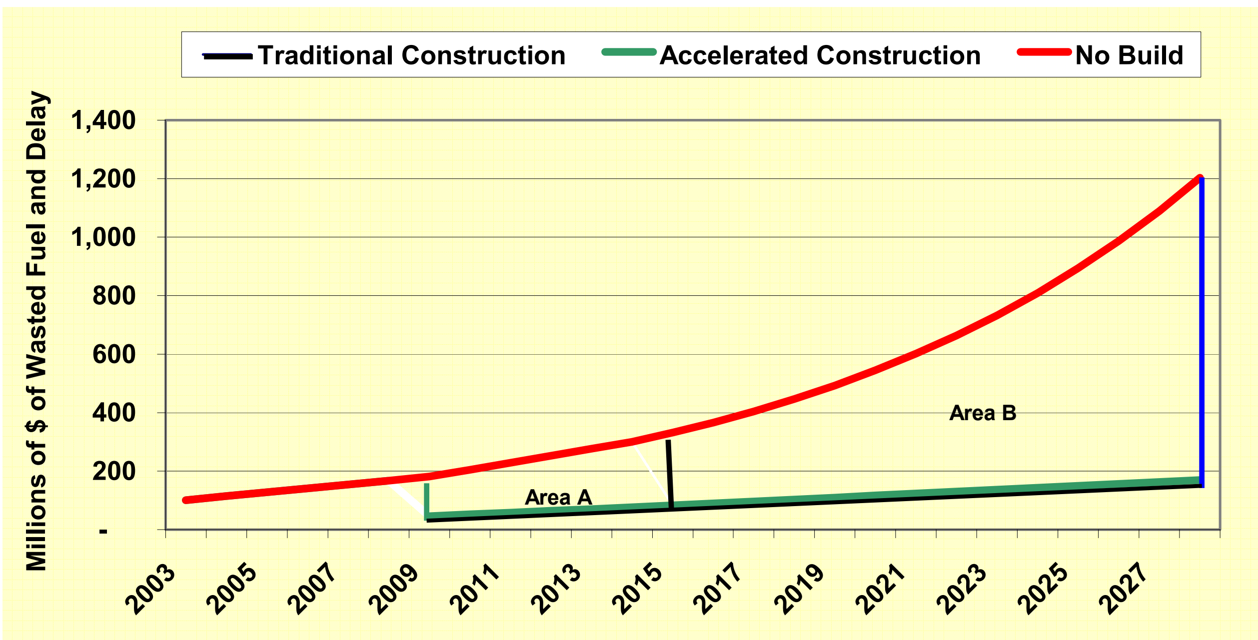
Exhibit 41: Katy Corridor Estimated Annual Delay

Annual Person-Hours of Delay (in 1000s)	2003	2009		2015	
		Accelerated Schedule	Traditional Schedule	Accelerated Schedule	Traditional Schedule
Katy to Barker-Cypress	520	255	855	585	585
Barker Cypress to Sam Houston Tollway	1,585	965	3,100	1,705	1,705
Sam Houston Tollway to I-610	2,735	845	4,685	1,550	1,550
I-610 to Downtown	345	385	640	575	575

The Benefits of Accelerated Construction

Exhibits 42 and 43 present two different perspectives on the costs associated with congestion on the Katy Freeway. In Exhibit 42, the potential effects of a "no-build" scenario are shown out to the year 2028 (a 25-year horizon from the base year of 2003). "Area B" on Exhibit 42 represents the differential that exists between the congestion costs from not building the Katy Freeway improvements versus completing the improvements in 2015 under a more traditional construction schedule. "Area A" on Exhibit 42 represents the cost differential from completing the project in 2009 versus 2015. Area A plus Area B, then, show the total cost savings in extra travel time and wasted fuel from 2009 to 2027 as a result of the improvements.

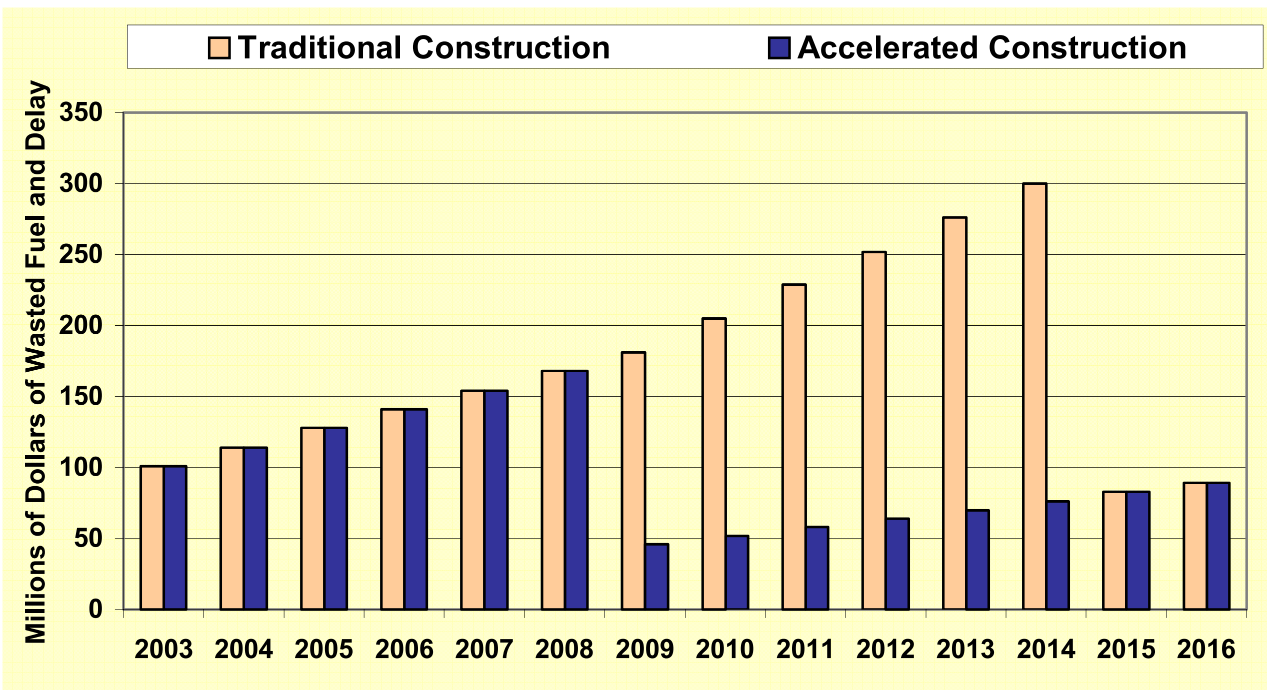
Exhibit 42: Cost of Wasted Fuel and Delay on the Katy Freeway Under Alternative Construction Scenarios



As a practical matter, it is unlikely that delay levels in 2027 represented by the "No Build" curve would actually be realized on the Katy Freeway. It is more likely that a significant portion of this delay would be shifted to other roadways as commuters and others sought alternate routes, and other locations for jobs, shopping and homes. Because of the uncertainty associated with these long-term projections, delay calculations were not done for "Area B" on Exhibit 42 and rather, were focused on the nearer-term benefits associated with "Area A". Exhibit 43 shows a more detailed graph of the benefits associated with accelerating the Katy Freeway improvement – i.e., the benefits from 2009 when the project is scheduled to be completed under the accelerated schedule and 2015, when it would be completed under the traditional schedule.

In 2003, as the project was started, it was estimated there were 5.1 million person-hours of delay on the Katy Freeway. [*See Appendix III, Note 1*.] As illustrated in Exhibit 43, the value of that delay and the fuel wasted sitting in congested traffic amounted to just over $100 million. By 2009, without the freeway improvements and with the traffic growth, it is estimated that there would be 9.3 million person-hours of delay with a time and fuel value of $181 million annually. The traffic volume growth is estimated to result in even longer congestion periods and slower speeds; when those effects are combined with more travelers, hours of delay and gallons of wasted fuel increase dramatically. With the freeway improvements, it is estimated that annual delay in 2009 will be reduced to 2.5 million person-hours with an estimated value of $46 million – an annual savings of $135 million and 6.8 million fewer person-hours stuck in congestion as a result of completion of the project.

Exhibit 43: Cost of Wasted Fuel and Time on the Katy Freeway under Alternative Construction Scenarios



If the Katy Freeway project were built on the traditional schedule (i.e., with completion in 2015), by the time the project was completed there would be an estimated 16.8 million person-hours of delay with a time and fuel value of almost $327 million annually. Once the project was completed in 2015, the number of person-hours of delay would be reduced to 4.5 million with a time and fuel value estimated at $84 million.

Economic Benefits of Accelerating Construction

The congestion reductions shown in Exhibit 43 are combined with project costs plus the economic benefits of the improvements and quantified in Exhibits 44 and 45.

In Exhibit 44, the cost of utility relocation and the cost of contractor incentives are identified in the State Auditor's letter of March 29, 2005 related to the Katy Freeway

Reconstruction Project. In reality, there may be other costs associated with accelerating the construction schedule beyond utility relocation and contractor incentives (e.g. costs associated with implementing traffic management strategies to minimize delay). However, the extent of such costs, if they exist, are not known at this time. Further, it should be noted that the acceleration costs that are part of the Katy Freeway projects are atypical of other accelerated projects. In the vast majority of cases, as is noted in Section 2 of this report, and the hypothetical cases illustrated in Exhibit 45 later in this section, there are no costs associated with accelerated construction schedules beyond the cost of funds needed to finance the project.

Exhibit 44 also includes an estimate of the savings in cost resulting from avoiding construction cost inflation that would be incurred between the period from 2009 to 2015 under a traditional construction schedule. *[See AppendixIII, Note 2.]*

The other critical value in Exhibit 44 relates to the project's effect on improving the business climate by providing lower travel times for raw and finished good shipments, lower service and delivery costs, and more efficient use of personnel. As shown, the economic benefits to business of the lower congestion levels are estimated to be almost $1.8 billion over the 2009 to 2015 period. This estimate was derived from a FHWA-sponsored study by Nadiri and Mamuneas that identified a 16 percent annual return on the initial construction investment in the form of increased business efficiencies. In this study, a more conservative rate of return of 12 percent each year was used. *[See Appendix III, Note 3.]*

The combined total benefit of the reduction in delay, the accompanying reduction in travel times from reduced delay, wasted fuel, returns to the economy, and construction costs saved due to inflation is estimated to be almost $2.8 billion versus a total cost of accelerating construction of $309 million. The net benefit is almost $2.5 billion over the life of the project with a resulting benefit/cost ratio of 9 to 1.

Exhibit 44: Costs and Benefit of an Accelerated Construction Schedule (in millions)

Costs of Improvements:		
Construction	$ 1,402	
Right of Way	$317	
Utility Relocation	$325	
Design and Program Management	$266	
Administrative Costs	$111	
TOTAL	**$2,421**	
Costs of Accelerated Schedule:		
Cost of Utility Relocation Associated with Accelerated Construction		$75
Cost of Contractor Incentives Associated with Accelerated Construction		$61
Cost of Funds		$173
TOTAL COSTS OF ACCELERATED SCHEDULE		**$309**
Benefits from Accelerated Schedule (2009-2015):		
Time Savings		$789
Fuel Savings		$289
Returns to the Economy (calculated at 12% return based on FHWA study)		$1,810
Construction Cost Inflation Saved		$168
TOTAL BENEFITS OF ACCELERATED SCHEDULE		**$2,767**
TOTAL BENEFITS OF ACCELERATED SCHEDULE LESS COSTS		**$2,458**
Benefit/Cost Ratio		**9.0**

In sum, there are an estimated $2.7 billion in total benefits associated with accelerating the construction schedule less $309 million in total project acceleration costs. Consequently, the net benefit of accelerating construction on the Katy Freeway is almost $2.5 billion, representing a benefit cost ratio of 9 to 1. Discounting the impact of the economic benefits altogether, the "cash" benefits alone from accelerating the schedule outweigh the costs by $148 million ($168 million in construction inflation costs plus $289 million in fuel savings less $309 in acceleration costs) and, still, the project is completed six years faster.

To go from this particular case study to a more hypothetical analysis, it is possible to estimate the potential benefits of extending this concept on a broader scale across each of the metropolitan areas included in this study. As shown in Exhibit 45, using the same accelerated construction concept produces positive benefit/cost ratios in each case. Obviously, to produce an estimate of this type, as in the case of the Katy Freeway case study, several assumptions have to be made. In this instance, no additional costs associated with right of way purchases or with contractor incentives were made, because, as noted earlier, those costs were particular to the Katy Freeway project. It was also assumed that the number of lane-miles in significantly congested corridors was equal to 25 percent of the total freeway lane-miles to be added under the TMMP Needs-Based scenario.

Clearly, the desirability of accelerating construction programs like what was done in the case of the Katy Freeway must be analyzed on a project-by-project basis. However, based upon the benefit/cost ratios shown from the hypothetical projects shown in Exhibit 45, it seems clear that such an approach could yield significant benefits and is worthy of serious consideration and detailed analysis on a project-by-project basis.

Exhibit 45: Estimated Costs Versus Benefits of Accelerating Construction in Hypothetical Projects (all values in million of $)

Benefit and Cost Component	Austin	Corpus Christi	Dallas-Ft.Worth	El Paso	Houston	Hidalgo	Lubbock	San Antonio	Total
Hypothetical Cost of Improvements	3,567	89	11,367	1,651	16,550	618	107	2,062	36,011
Costs of Accelerated Construction									
Cost of Funds	128	2	406	59	591	14	2	74	1,276
Benefits of Accelerated Construction									
Time Savings	575	11	1,873	182	3,091	59	5	317	6,113
Fuel Savings	210	4	685	66	1,131	22	2	116	2,236
Returns to Economy	744	28	2,370	344	4,080	193	33	430	8,222
Inflation Cost Saved from Accelerated Construction	124	2	394	57	574	14	2	72	1,239
Total Benefits of Accelerated Construction	1,653	45	5,322	649	8,876	288	42	935	17,810
Total Benefits in Excess of Costs	**1,525**	**43**	**4,916**	**590**	**8,285**	**274**	**40**	**861**	**16,534**
Benefit/Cost Ratio	**11.9**	**20.8**	**12.1**	**10.1**	**14.0**	**19.0**	**19.4**	**11.6**	**13.0**

Note 1: The hypothetical cost of improvements are shown for illustration purposes only. They are not counted in the benefit/cost ratio calculation because the issue at hand is only whether the project will be built on a traditional or accelerated schedule.

Note 2: Congestion levels on freeway corridors included in this analysis were assumed to be 25 percent worse that congestion levels area-wide.

Note 3: In Austin, Dallas-Ft. Worth, El Paso, Houston and San Antonio projects were assumed to be accelerated from 6 years to 3 years. In Corpus Christi, Hidalgo and Lubbock projects were assumed to be accelerated from 4 years to 2 years.

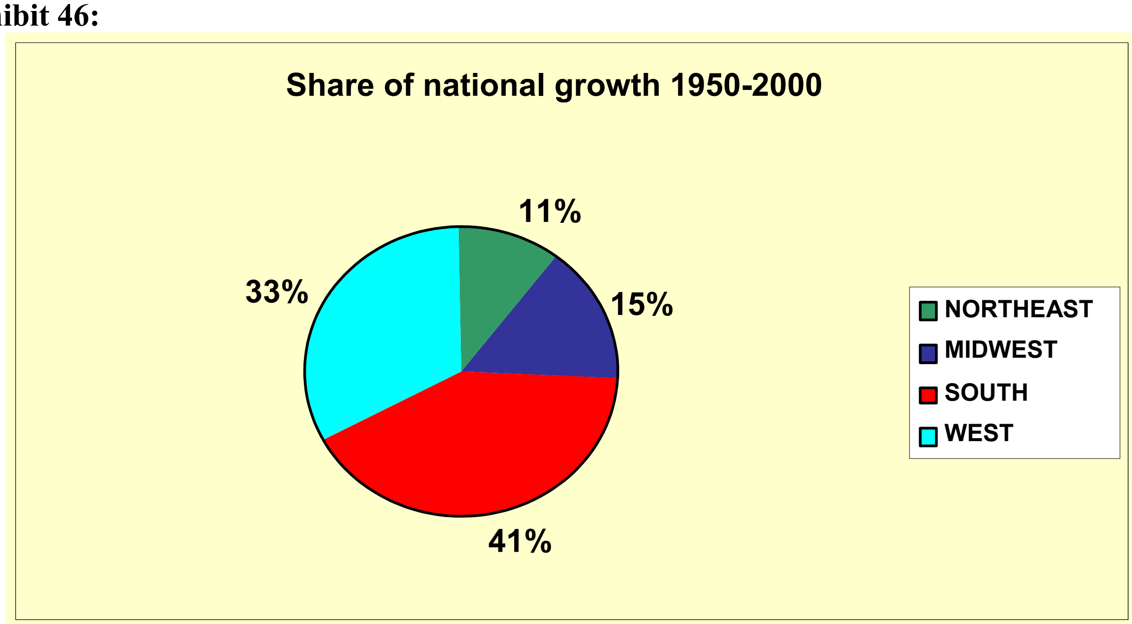
Note 4: In the hypothetical examples above, the short duration of the projects has the effect of increasing the actual net cost benefit of acceleration because the difference between the "traditional" construction schedule versus the "accelerated" construction schedule is less which, in turn, reduces the cost of funds. However, it is important to note that the benefit/cost ratio remains substantial.

SECTION IV
Highway Landscaping and Beautification

As we move into a new era of labor force change in which the nation's labor force is aging sharply, a new set of factors will serve to guide economic development. One of these will be the need to attract skilled workers. In many cases these workers will be working in fields, such as high technology and services, where they can be almost anywhere. Economists have referred to this new world as one constituting foot-loose industries that are not tied to natural resources or major physical advantages such as deep harbors. Their needs are often quite basic: good communications, good highway services, and good airport access. After that they can be wherever they want to be. They can be "amenities-seeking." Employers will more and more locate where skilled workers are or where they want to be—whether that is an area of great natural beauty or cultural attraction—often university environments supporting research is key.

A large part of national growth over the last fifty years has been amenity seeking as the population has shifted toward warmer, less crowded areas of the nation. The south has dominated in that growth as shown in the exhibit and Texas has been a major part of that.

Exhibit 46:



Source: Reference (1)

Potential Benefits of Beautification Improvements

In that environment of competition for work force, cities, counties and states will seek more to attract employees rather than employers—with a skilled workforce in place the employers will follow. Among the amenities such highly sought-after labor forces will seek are low-cost housing, good schools, good weather, cultural attractions, easy commuting and travel in general, and an attractive environment. In that case, one way in which communities will compete will be in general attractiveness and a part of that will be transportation facilities that are an attractive part of the environment. Roadway attractiveness with good design and attractive plantings that fit into its surroundings will be a significant part of that.

This is not to argue that skilled workers will decide to move to Texas cities because of their attractive freeways, but those facilities will be a part of an overall image that either attracts or repels. Indeed when asked about what makes an attractive roadway, surveys of urban residents and travelers indicate it is the area outside the right-of-way that captures most of the visual attention (2). There should be an effort to balance the cleanliness and aesthetic quality of the area next to the roadways with the visibility that most commercial establishments like for their businesses.

In many cases it will not be a case of basing the aesthetic investment decisions on benefits and costs, but rather on competitiveness with other cities and states and how they choose to compete. If other communities in other states are making investments in more attractive roadways and developments, it could well be necessary to make similar investments to remain competitive.

For example, Chicago's Mayor Daley has vowed to be remembered as the tree-planting Mayor. He is encouraging the planting of trees everywhere in the city where they can be accommodated saying, "Trees soften the edges of life in a large urban setting," "They add beauty to the environment, help cleanse the air, increase property values and provide shade that can lower energy costs on hot days." The city's Bureau of Forestry plants 5,000 trees every year. In addition, another unit of government called Greencorps Chicago has been created to assist local groups with free plantings, advice, and training to help beautify the community. In addition, these activities contribute to better air quality, and to the reduction of heat-island effects. The more than 4 million trees in Chicago are viewed as a major community resource.

Tourism is often an important basis for metropolitan beautification. Many cities actively invest in major parks, floral displays, fountains, etc. to support greater tourism attraction. Of course these same parks are there for the citizenry to enjoy as well. Geneva, Switzerland, famous for its flower gardens, justified them on the grounds of tourism attraction but recognized that these forms of tourism investment were an "export" that one gets to keep in the form of greater urban amenity.

There have been several studies of the costs of various aesthetic treatments to the roadside and roadway, but much of the benefit calculation research has focused on environmental issues such as erosion control, or the human factor benefits of landscape aesthetics (3). In addition, there have also been studies of the reduction in the urban "heat island" effects caused by large expanse of uncovered concrete, the absorption of pollutants by plant material and the reduction in noise and driver stress (4,5).

The categories of potential benefits include those that can be monetized such as reductions in travel delay and vehicle crashes and those that clearly have a value but are more difficult to value as financial benefits such as pollution reduction, noise abatement, driver stress reduction and other factors. Aesthetic treatments in general are recognized as important factors in the perception and acceptance of major roadway improvements, and in many cities these improvements appear to be a significant feature of public input, public discussion and acceptance of a major construction program (6).

An extensive review of the literature performed by the Washington State DOT found no studies that measured the effects of landscape on driving performance. It is believed that this remains a viable course of study and the effects on driver performance and safety might eventually be more relevant to some audiences than relatively simplistic benefit/cost analyses, but an examination of only a few effects yields some important conclusions about the level of benefits that might be expected (2).

Aesthetic treatments pay off in economic benefits that can be estimated in real estate values, as well. The market value of homes with significant trees is three to seven percent higher than similar, but non-vegetated developments (5). Studies of developments adjacent to roadways developed with desirable landscaping and design treatments have also seen increases in the property values -- even in neighborhoods next to freeways (4).

For this and other reasons, TxDOT has incorporated a number of aesthetic elements into the standard roadway design practices. These include both landscaping and vegetation elements and structural or design treatments that enhance the beauty of the corridor (2). Many landscaping treatments have project elements that include the use of plantings that result in reduced maintenance needs.

Process for Developing Beautification Treatments

Beautification treatments are desirably done as part of the project design and community involvement processes that are used for roadway or transit projects. There may be community members who take a specific interest in the aesthetic elements and the better projects include citizen input in the process, but there is a cost to these elements. Communities with great interest in aesthetic treatments may be required to provide on-going maintenance funding for unique ornamental designs, but most supports, walls and structural element costs are included as part of the project costs.

The Texas Legislature passed legislation requiring that roadway aesthetics be addressed in a Landscape and Aesthetic Master Plan for cities in Texas with populations of 100,000 or more (see Article VII-35, Rider 57, 2002-2003 General Appropriations Act). Such “Green Ribbon” plans have been developed for San Antonio, Laredo, Corpus Christi, Amarillo, Abilene, and Lubbock and are under development in Waco and Beaumont among other major cities. A report similar to this was also completed in the Houston area in 1999 (7). A principal goal of these plans is to establish a policy for the specific TxDOT region that incorporates local elements and plants in a landscape and aesthetics program (2). Each of these Plans has involved significant public participation. The finished plans are actually guides that identify and prioritize the most pressing issues, and describe specific programs or methods that will be the primary tools used to deal with them. The list of specific items in each Plan varies with the communities and the region.

Most of the urban freeway corridors have limited space between the mainlanes and the frontage roads, therefore, the developments adjacent the freeway will form a substantial part of the visual impression of the corridor. A survey (2) among Dallas residents found that except for the North Central (US75) Expressway which had a significant level of ornamental planting and structural additions, the most frequent generator of favorable and unfavorable responses was the area outside of the right-of-way. Addressing the quality and look of adjacent developments will take time, but providing maintenance and litter control are relatively less complex activities that have significant benefits in improving the visual landscape.

What Type of Treatments?

"Aesthetics" refers to the non-plant elements such as bridges, retaining walls, specialty paving, guard rails, lighting, etc. Many aesthetic treatments are considered a normal component of a roadway project and are included in most new construction projects (8). Their relative cost, in these cases, is quite low and typically included in new capacity or major reconstruction projects.

The landscape portion of this effort has resulted in a broadly similar practice on TxDOT construction efforts. "Naturalized plantings" that replicate native plant communities are installed within the right-of-way at the conclusion of construction activity. Low maintenance is a key factor from a cost perspective and from the driver distraction that may result from the maintenance efforts. Once the vegetation is established, the maintenance activity is greatly reduced. In these cases, the communities get a range of benefits including improved environmental conditions, bird and small mammal habitat, and water quality with no need for private funding or effort to maintain the treatment and a low expenditure of annual maintenance funds required for TxDOT. Statewide guidelines for creating and maintaining these types of projects are in development, but the recommendations below might be considered a way to begin aesthetic improvements.

1. TxDOTs responsibility is to provide a basic level of landscape maintenance.

2. TxDOT could fund (in part, or whole depending on the project) and install projects but continue current practice of requiring cities to do all maintenance.

3. Focus TxDOT plantings to large-scale plantings within key freeway interchanges.

4. Work with communities and adjacent landowners to coordinate frontage improvements.

5. Promote Public Improvement Districts as a way to get commercial developments to pool their money to fund maintenance of improvements in important corridors.

6. Assist communities in developing litter awareness programs and promoting appropriate landscaping, screening, and site upkeep of adjacent properties.

Significant landscaping adds to maintenance costs and efforts, and in some cases requires workers to be in less safe or distracting areas. Increasing maintenance schedules and employing better maintenance techniques will be much cheaper and have more visual impact. An extensive initial investment in landscaping that is poorly kept will send the very opposite message of the original intent.

Naturalized Mass Plantings


Ornamental plantings are often appropriate for urban sites but typically require mowing within the planting and weed control in shrub beds.

The maintenance of ornamental planting within the right-of-way requires a fairly high degree of specialized knowledge about plants and their needs. It also requires regular attention in the maintenance of irrigation systems as well as changes in plant health. Even simple plantings such as a line of trees in turf require a fairly high degree of care.

The ideal planting for the highway roadside is one in which plants can reach a state of maturity and are able to "maintain themselves" with little or no inputs by man. This occurs all the time in nature; native plant communities have persisted for long periods of time without maintenance of any kind. The specific mechanisms that make this possible have evolved over many millennia, and these may be used to create low-maintenance landscapes in the roadside.

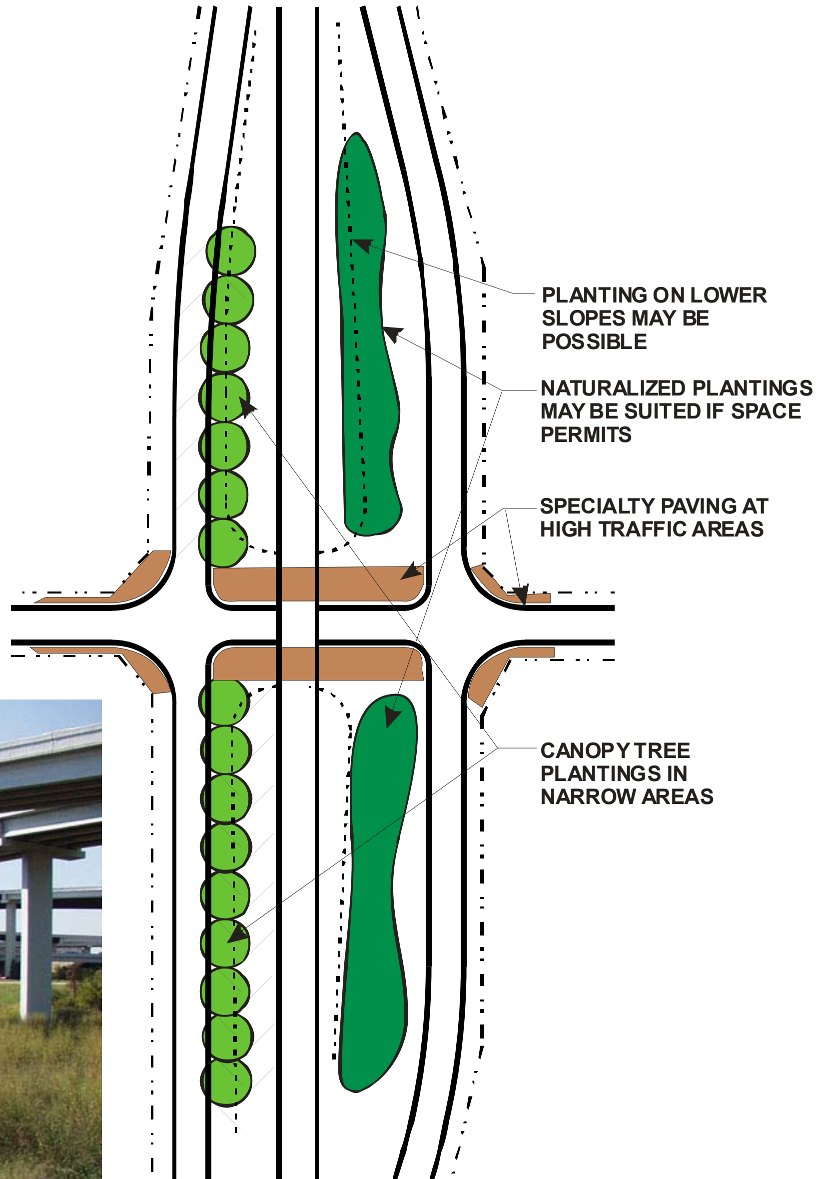
A "naturalized planting" approach that uses native plants and takes advantage of their longevity to achieve a self-sustaining, low maintenance planting design can add beauty at a relatively modest initial cost and very low on-going maintenance cost. These are especially good treatments for freeway-to-freeway interchanges, which contain larger areas of open ground.

The installation cost for these mass plantings run around $55,000 per acre. This is about one-quarter the cost per square-foot of an ornamental planting similar to the type on US75 in the Dallas area. The mass planting will eventually be "abandoned" (no maintenance other than litter control) while the maintenance of ornamental plantings never ends (8).


Unmaintained plant groups, usually existing wooded areas saved during construction, are common to many roadsides.

Depending on the slope of the ground and the space available, however, these types of plantings may also be appropriate along freeways. Plantings in these areas should be limited to individual trees in turf utilizing permanent irrigation systems. Local communities have been involved in funding the added long-term maintenance of these types of projects.

The edges of the traffic lanes should be treated with specialty paving such as patterned concrete or concrete pavers. Bridge structures should be considered for enhancement through the use of color.



Conceptual design ideas for urban freeway landscaping.

Naturalized planting in freeway interchange.

Turf areas in the interchange

- Grass vegetation within the interchange may be seeded to encourage the development of native prairie species and/or wildflowers. These areas may be maintained to within a single strip-mow width of the pavement edge or back of curb.

- Management schedules for grass or wildflower plantings should be prepared on a site-by-site basis.

Tall grasses, even some weedy growth will look appropriate between naturalized plantings.

This approach to landscape planting is a technique that adds environmental value to the roadway and to the community. Large, native plant communities can provide needed habitat within or near urban developments without compromising driver safety. Mature plantings improve air quality by capturing dust. Planted areas also can absorb more rainfall and hold it for a longer period before it enters drainage ways. The increased leaf surface on the ground surface is also an excellent filter contributing to cleaner water runoff.

Importantly also is the low, long-term costs that result from letting natural systems establish and reach an equilibrium. This allows more sites to be addressed without overtaxing limited maintenance budgets.

This approach is not a replacement for ornamental plantings that would be more appropriate to narrow sites and high-traffic urban areas. Those types of plantings will be developed on a site-by-site basis as part of community-requested participation projects.

The results of such a project in the Austin District (9) can be viewed at: http://tti.tamu.edu/enviro_mgmt/projects/mopac/. The project demonstrates the benefits and possibilities of urban environmental design solutions. The design solutions show that visual appeal, water quality and habitat goals in an urban area can be met while roadside maintenance needs are minimized.

Bridges

Structural design alternatives offer the opportunity to introduce more dramatic and unique designs into the roadway. There are many creative and unique examples of roadway structures throughout the country. The ideal design is one that is attractive and stays within the standard design and construction practices to avoid adding excessive costs to the project (8).

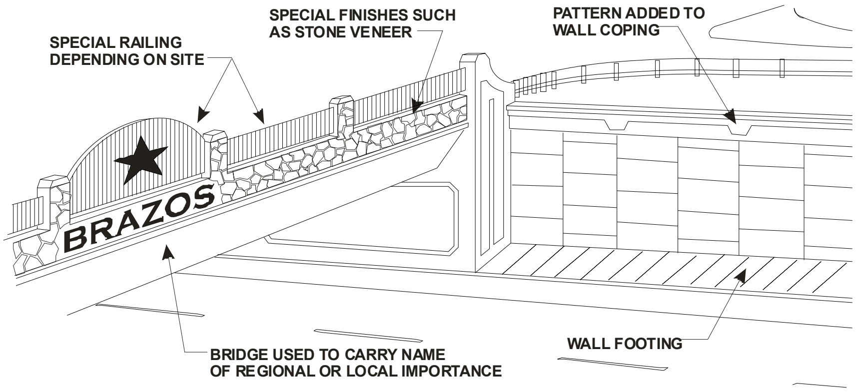
Columns and caps also receive special treatments. These include enlarged column bases and embellished caps. Color as well as patterns (such as brick) usually accompanies these improvements. The ends of the caps are increasingly being used to add details such as stars or other symbols.

Source: Reference (10)

Source: Reference (10)

The effect will be reduced significantly by introducing another element between the pavement and wall. A short wall topped by another wall behind that gives a terraced effect is easy to maintain, provides a better aesthetic quality than one single wall, and is easier to maintain than a narrow planted strip of vegetation. This technique reduces the apparent height of the wall because the setback and low intermediate wall separates the retaining wall from the pavement, making each appear smaller.

A bridge is a logical design element to introduce a visually distinct character from surrounding walls or embankments. This may be accomplished by interesting shapes or details or by using contrasting materials or finishes. The bridge supports and walls can be significant visual elements and can be finished with a locally inspired architectural treatment.



Source: Waco TxDOT District, Reference (10)

The bridge rail is an important roadway design element. It must provide for safety in the event of a crash, but it can also improve the view for the motorist on the bridge and is very prominent when viewed from the freeway or street below. Motorists have consistently expressed a desire to be afforded a "view" from a bridge. The concrete barrier design below will redirect impacting vehicles, provide viewing opportunity, and break up the solid concrete wall typical of most bridge rails.

Source: Reference (10)

In place of slopes, vertical retaining walls can be used in conjunction with relatively simple landscaping treatments. In addition to requiring less space, these structures offer numerous options for aesthetic enhancement including surface texturing, color and patterns that are effective at adding interest and a distinctive appearance to a roadway. Although much preferred to a plain concrete wall, any texture or pattern that is repeated for significant distances can lose its effectiveness. Artistic elements or graphic designs have been successfully used to promote local culture and to add interest to the roadway.

Source: Reference (10)

Concrete Traffic Barriers

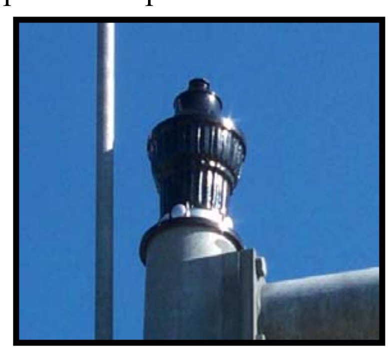
Concrete barriers are a common roadway structure in the roadway, but they are typically gray with very little aesthetic quality, although colors have been used in some projects. The Federal Highway Administration (FHWA) approved a set of standards for patterns and textures along the face of the barrier wall in December 2002. Incorporating patterns, texture, and color into concrete barriers is not prohibitively expensive. If extensive treatments such as in the accompanying photo are used on all barriers, however, the cost could be significant and the uniqueness will be lost. The aesthetic barrier treatments should be limited to visually significant areas.

Source: Reference (10)

Signal and Sign Poles

Traffic signal poles and lighting standards, particularly on frontage road intersections, can have a significant effect on the aesthetics of a scene. Two approaches might be used to improve the appearance of these fixtures.

- Use a more attractive finish—such as a powder coat—for the standard fixtures.
- Use specialty or historic period fixture designs that complement nearby architecture. The use of antique-style lighting near historic commercial centers is an example. Relatively inexpensive add-ons might be used on the tops and bottoms of poles to improve the look of an intersection.



Source: Reference (10)

Source: Reference (10)

Median Landscaping Treatments

The potential monetary benefits of landscaping in the median are substantial. One aspect of the benefits of landscaping treatments is that the amount of travel delay that occurs during a crash or vehicle breakdown could be reduced if a visual barrier was installed between the two directions. A double row of shrubs or short trees installed in a 15-foot wide median area is used as an example case. This width is identified in the Houston Green Ribbons Project (7) as a desirable landscaping improvement on an urban freeway. This width would be sufficient to block the ability of motorists to see the opposite direction of traffic. Plants in the median would be 8 to 10 foot tall evergreens such as oleanders, wax myrtle or Carolina cherry laurel in wetter climates and evergreen sumac in dryer climates. The vegetation would be planted at ground level to allow for weed growth that does not diminish the visual quality (which results in lower maintenance requirements).

A conservative estimate of the relative increase in costs due to landscaping treatments would assume that no landscaping is included in current construction program costs. The estimated cost for shrubbery, topsoil and irrigation for this median area is $105,000 per mile (11). It is interesting to note that plant material and paving to prevent erosion on embankment slopes have approximately the same cost. If all the right-of-way necessary to construct this median were required in every mile of urban freeway the estimated cost would be an additional $330,000 per mile, bringing the total additional cost to $435,000 per mile. Given the manner in which land parcels are purchased, it is unlikely that all freeway projects would incur this cost.

The estimated cost per lane-mile of roadway, by comparison, is substantially higher in the developed areas of the eight largest regions in the Texas Metropolitan Mobility Plan (12). A sample of projects over the last four years was used to develop the cost groups in Exhibit 47.

Exhibit 47: Estimated Roadway Construction Costs

Area Type/ Roadway Type	Construction Cost Per Lane-Mile (millions)		
	Dallas/Houston	Austin/ San Antonio/El Paso	Lubbock/Corpus Christi/Hidalgo
CBD Freeway	$ 9.3	$ 7.3	$ 5.7
CBD Arterial	$ 5.1	$ 5.1	$ 4.6
Urban Freeway	$ 6.8	$ 5.4	$ 4.6
Urban Arterial	$ 4.8	$ 4.4	$ 3.1
Suburban Freeway	$ 5.8	$ 5.6	$ 3.2
Suburban Arterial	$ 2.1	$ 2.0	$ 1.9
Rural Freeway	-	$ 3.0	$ 2.7
Rural Arterial	$ 1.1	$ 0.7	$ 0.7

Source: Reference (12)

Median Landscaping Benefits

Exhibit 48 indicates the amount of delay due to crashes and vehicle breakdowns in each of the large metropolitan areas included in the Annual Mobility Report (13) on freeways and principal arterial streets. Studies of the causes of incident delay for the Federal Highway Administration (9) indicate that delay during incidents in the opposite direction of traffic (also known as "rubbernecking") is conservatively estimated as 15 percent of total incident delay. Using a value of 15 percent of incident delay as a starting point, and the areawide estimates of delay and roadway miles in the 2004 Annual Urban Mobility Report (13), an estimate of the potential savings due to the elimination of opposite direction "rubberneck" delay was created. Fuel savings and travel delay reductions totaling $17.90 per hour are the only cost elements included in this estimate; including the cost of collisions would dramatically increase the value of this benefit.

The reduction in delay estimated in this conservative benefit compares favorably with the estimated cost of median landscaping treatments in the largest urban areas. The average cost per mile for the extra landscaping is met or exceeded by the potential "rubbernecking" cost savings in five of the six areas. When right-of-way is added to the calculation, the value of "rubbernecking" delay savings alone could meet half of the median landscaping treatment costs in Dallas-Fort Worth, Houston and Austin. While the areawide average values for the other regions are not as high, there may be sections of congested corridors in San Antonio and El Paso that might also have incident related congestion costs that would pay for extra landscaping and rights-of-way to eliminate the effect of "rubberneck" delay. And the "rubberneck" delay is only one component of potential savings.

Exhibit 48: Potential Effect of Median Visual Barrier on Incident-Related Delay

	Annual 2002 Incident Delay (1000)		Roadway Miles		Incident and Delay Hours per Mile (1000)		Incident Delay Cost per Mile ($1000)		"Rubbernecking" Cost per Mile ($1000)	
Urban Area	Frwy	Arterial	Frwy	Arterial	Frwy	Arterial	Frwy	Arterial	Frwy	Arterial
Austin	8,000	5,100	102	184	78	28	$1,404	$496	$211	$74
Corpus Christi	380	280	56	77	7	4	$121	$65	$18	$10
Dallas-Fort Worth	63,100	21,900	518	988	122	22	$2,180	$397	$327	$60
El Paso	2,400	1,600	51	186	47	9	$842	$154	$126	$23
Houston	50,400	16,900	364	698	138	24	$2,478	$433	$372	$65
San Antonio	8,000	4,000	212	257	38	16	$675	$279	$101	$42

Note: Delay, road miles and incident cost taken from 2004 Annual Urban Mobility Report, Reference (13)
Note: Rubbernecking effect estimated as 15 percent of total incident delay, Source: Reference (14).
Note: Cost of urban right-of-way estimated as $4.20 per square foot (Reference: TMMP Final Report). Cost for a 15-foot wide strip equals $330,000 per mile. Cost for median landscaping treatment is estimated as $105,000 per mile. Reference (11)

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SECTION V
Emissions from Alternative Investment Scenarios

A simplified method was used in the Texas Metropolitan Mobility Plan (TMMP) effort (1) to identify the effect of transportation improvements on mobile source emissions. Such a method was appropriate given the level of uncertainty in the future year roadway system configurations. The goal of the effort was to develop an understanding of the effects of transportation system improvements AND technological advances in vehicle pollution control technologies on mobile source emissions.

Results

The TMMP investigation identified that the biggest improvement in emissions between 2000 and 2025 will be due to technological advances in fuel and vehicle technology. Of more interest in this analysis is that mobility improvements that reduce stop-and-go conditions also reduce vehicle emissions.

The performance measure developed by the combined TxDOT and Metropolitan Planning Organization group was an emissions index (2) that compared future conditions to existing emissions. The air quality analysis was designed to examine relative levels of mobile source emissions during peak periods – the time of most effect from the additional transportation investments being studied. The well-established air quality standard conformity analysis was not replicated, and the TMMP estimates are not a substitute for a comprehensive air quality analysis. The index is calculated as the ratio of future year emissions to base year emissions. Emissions for the morning and evening peak periods on freeways and principal arterial streets from volatile organic compounds and nitrogen oxides are added together to produce a total amount of emissions.

- Volatile Organic Compounds (VOC) -- Carbon-containing compounds that evaporate into the air, may be toxic and contribute to the formation of smog (3).

- Nitrogen Oxides (NOx) -- Combustion processes emit a mixture of oxides of nitrogen, primarily nitric oxide (NO) and nitrogen dioxide (NO_2), collectively termed NOx. Nitrogen dioxide has a variety of environmental and health impacts. It is a respiratory irritant that may exacerbate asthma and possibly increase susceptibility to infections. In the presence of sunlight, it reacts with hydrocarbons to produce photochemical pollutants such as ozone. Nitrogen dioxide emissions can also be further oxidized in air to acid gases, which contribute to the production of acid rain (3).

Exhibit 49 illustrates one part of the results. Total peak period emissions decrease in every metropolitan region and the total for all eight regions decreases from 459 tons to between 82 and 92 tons. The Index values show that peak period emissions will decrease between 60 and 85 percent relative to 2000 emissions (Index values between 0.16 and 0.38). The worst values are those for the scenario where the transportation network is not expanded beyond that in place in 2000 (No Build), a model developed for comparison purposes only. The MTP and Needs scenarios both have lower emissions than the No Build.

Exhibit 49: Peak-Period Emissions Estimates from Texas Metropolitan Mobility Plan Scenarios

Urban Area	Peak-Period Emissions (Tons)				2025 or 2030 Peak-Period Emissions Index [1]		
	2000 Base Year	Future Year Scenarios (2025 or 2030)					
		No Build	MTP	Needs	No Build	MTP	Needs
Austin	40.5	15.3	14.0	13.5	38	35	33
Corpus Christi	12.6	2.4	2.3	2.3	19	18	18
Dallas-Fort Worth	173	28.2	25.2	24.6	16	15	14
El Paso	20.5	6.3	5.6	5.4	31	27	26
Houston	136	23.8	21.5	21.4	18	16	16
San Antonio	56.2	11.5	10.9	10.7	21	19	19
Hidalgo	9.2	2.2	2.2	2.3	24	24	25
Lubbock	11.4	2.3	2.2	2.2	20	20	20
Total (8 cities)	459	92	84	82	20	18	18

Source: Reference (1)

Note: Peak periods are 6 to 9 a.m. and 4 to 7 p.m.

[1] 100 = Emissions in 2000 for each metropolitan region.

The emissions analysis presented in Exhibit 50 eliminates the effect of population growth from 2000 to 2025. To get a sense of the relative amount of emissions in comparable terms, the values in Exhibit 50 show emissions per million miles. The decline in emissions rates due to improvements in vehicle technology from 2000 to 2025 is even more apparent in this presentation, in which 2025 emissions are between 7 and 14 percent of 2000 emissions in the Metropolitan Transportation Plan scenario when adjusted for miles traveled. Emissions for the eight regions combined in the three scenarios are 11 to 12 percent of 2000 conditions.

Exhibit 50: Normalized Emissions Index Values

Urban Area	2000 VMT	Future VMT	Peak Period Emissions Rate (Tons per million daily miles traveled)				Future Percent of 2000 Peak Period Emissions		
			2000 Base	Future NoBuild	Future MTP	Future Needs	No Build	MTP	Needs
Austin	9,142,623	24,279,990	4.43	0.64	0.58	0.57	14%	13%	13%
Corpus Christi	2,690,268	4,079,592	4.69	0.58	0.57	0.55	12%	12%	12%
DFW	34,975,922	70,928,006	4.95	0.40	0.36	0.35	8%	7%	7%
El Paso	4,445,793	8,446,279	4.61	0.74	0.66	0.65	16%	14%	14%
Hidalgo	858,126	2,351,817	4.56	0.65	0.63	0.63	14%	14%	14%
Houston	34,954,524	64,961,085	3.89	0.37	0.33	0.33	9%	8%	8%
Lubbock	1,666,626	2,885,991	6.82	0.79	0.77	0.77	12%	11%	11%
San Antonio	10,976,573	17,823,823	5.12	0.65	0.61	0.60	13%	12%	12%
TOTAL	99.7 million	195.8 million	39.07	4.82	4.51	4,45	12%	12%	11%

Source: Reference (1) and GBC Analysis

Source: Reference 2

Mobile Source Emissions Rates and Speed

The cause of the emission reduction is evident in the emissions rates used for each travel speed on freeways and arterial streets. The emission rates are expressed in units of grams of pollutant per mile of travel. The computerized transportation planning model process estimates the vehicle speeds and miles traveled on each roadway link. The emissions estimation process uses the speed of travel to identify the emissions rate; the miles traveled are then multiplied by the rate to obtain a total emissions estimate in grams. Emissions for each link are added to get a regional estimate, expressed in tons.

Volatile organic compounds and nitrogen oxides have different types of non-linear relationships with speed. Emissions for the local average mix of cars, trucks and buses are shown in Exhibits 51 and 52, using Houston as an example.

- Emission rates for nitrogen oxides show a decrease from 2.5 mph to 15 mph, relatively constant rates until 40mph and then a slow but steady increase (Exhibit 51). This observation holds true for both freeway and arterial roads (2).

- The emission rates for VOC show a significant decrease from 2.5 mph to 10 mph on both freeways and arterials (Exhibit 52). Above 10 mph there is a steady slow decline in emission rate (2).

Exhibit 51: Nitrogen Oxide Emission Rates for 2000 and 2025

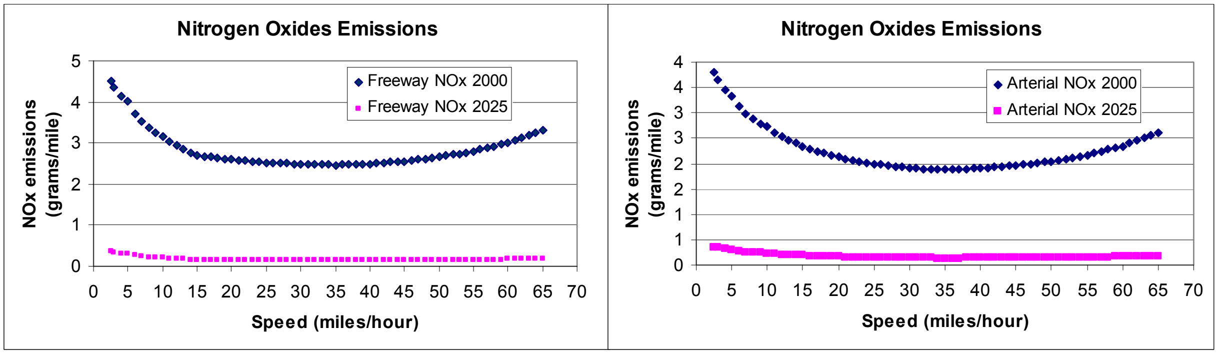
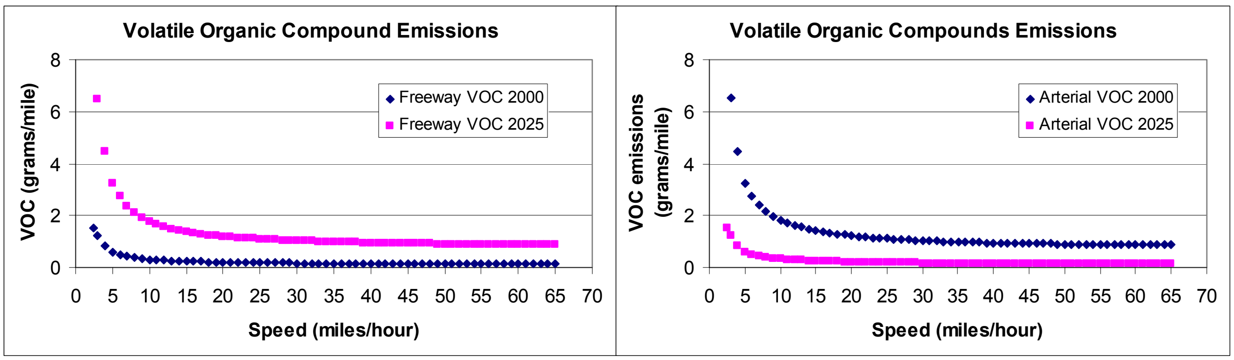


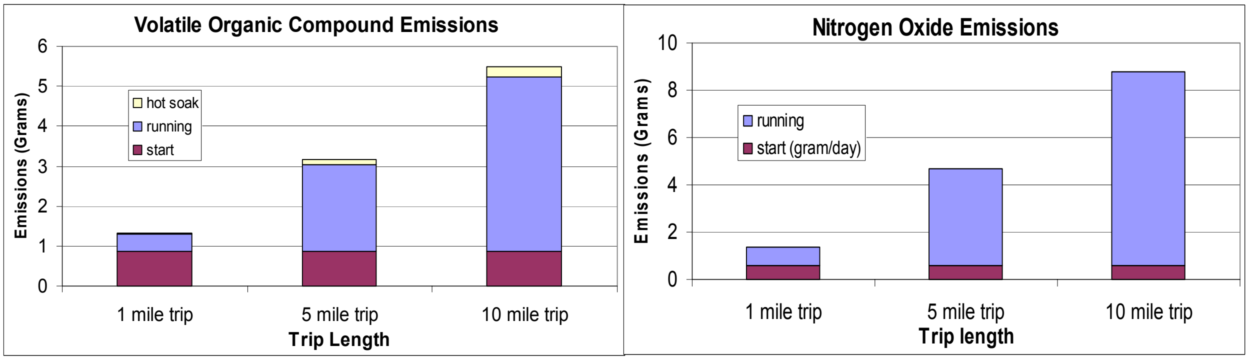
Exhibit 52: Volatile Organic Compound Emission Rates for 2000 and 2025



In addition to these "steady speed" emission rate values, emissions tend to be highest during acceleration. Engine operation is less efficient during these times and more unburned fuel is sent through the exhaust system.

The initial start-up of cold engines is also an important source of current emissions. The catalytic converters that are responsible for lowering emissions do not work well when cool. Evaporation from cooling engines, known as "hot soak," also contributes emissions even after the engine is turned off. The emissions from cold starts and hot soaks are not as dependent on speed or length of trip as the running emissions. Exhibit 53 illustrates the amount of these "fixed" emissions for passenger vehicle trips of different lengths.

Exhibit 53: Effect of Trip Length on Vehicle Emissions for Passenger Vehicles



Source: Reference 2

Technology Improvements

The NOx and VOC emission rates for both Arterial and Freeways are lower for the year 2025 than in 2000. The lower values of NOx and VOC emission rates in year 2025 are due to the technological advances in the automobile industry. Research and development on engine and emission control technology are developing better vehicular combustion systems and cleaner fuels, to control vehicular emissions. By the year 2025, vehicular fuel systems with better fuel combustion capacity will result in lower emissions of volatile organic compounds and nitrogen oxides. Cleaner exhaust systems and fuels will result in continued reductions in vehicle pollutant emissions despite increases in travel. These effects do not include the introduction of hybrid fuel vehicles into the fleet.

References

1. *Texas Metropolitan Mobility Plan: Breaking the Gridlock. 2004 Report of Progress and Action Plan for Continued Success*. Presented to the Texas Transportation Commission, October 2004.
2. Perkinson, D.G., B.S. Bochner, M. Boardman and T. Qu. *Developing an Emissions Index for the Texas Metropolitan Mobility Plan*. Texas Transportation Institute, College Station, TX, April 2004.
3. The Air Quality Archive. Glossary of Terms, 2005. http://www.airquality.co.uk/archive/index.php.

SECTION VI
Competitiveness and Traffic Congestion

Introduction

Achievement of the TMMP Mobility Objectives to reduce traffic congestion over the next quarter century can be expected to substantially improve the national and international competitiveness of Texas urban areas.

Traffic Congestion

In 2002,[1] the two largest urban (urbanized) areas in Texas generally had lower levels of traffic congestion than the nation's other 10 urban areas with more than 3,000,000 population ("very large" urban areas).[2]

- Dallas-Fort Worth had the most freely flowing traffic, with a Travel Time Index of 1.34 in 2002.[3]

- Houston had the fourth best rating, with a Travel Time Index of 1.39. Slow growing Philadelphia and Detroit ranked second and third, respectively.

Along with Atlanta, Dallas-Fort Worth and Houston are by far the fastest growing "very large" urban areas (population over 3,000,000) in the United States and occupy three of the top four positions among high-income world metropolitan areas.[4]Atlanta's traffic was worse in 2002 than in Houston and Dallas-Fort Worth, with a Travel Time Index is 1.42. This is despite the fact that Atlanta was the smallest urbanized area in the "very large" category. This situation reflects the fact that Atlanta has built insufficient roadway capacity to meet travel demand -- major planned freeway segments were cancelled and a regional arterial street network has not been developed. This deficiency has now been recognized, and the most recent regional transportation plan calls for developing a new "Cross-regional" grid of major arterials throughout the region.

The average Travel Time Index for the 10 largest urbanized areas outside Texas was 1.47. Los Angeles had the worst Travel Time Index, at 1.77, following by San Francisco-Oakland (1.55), Chicago (1.54) and Washington (1.50) (Figure 54).

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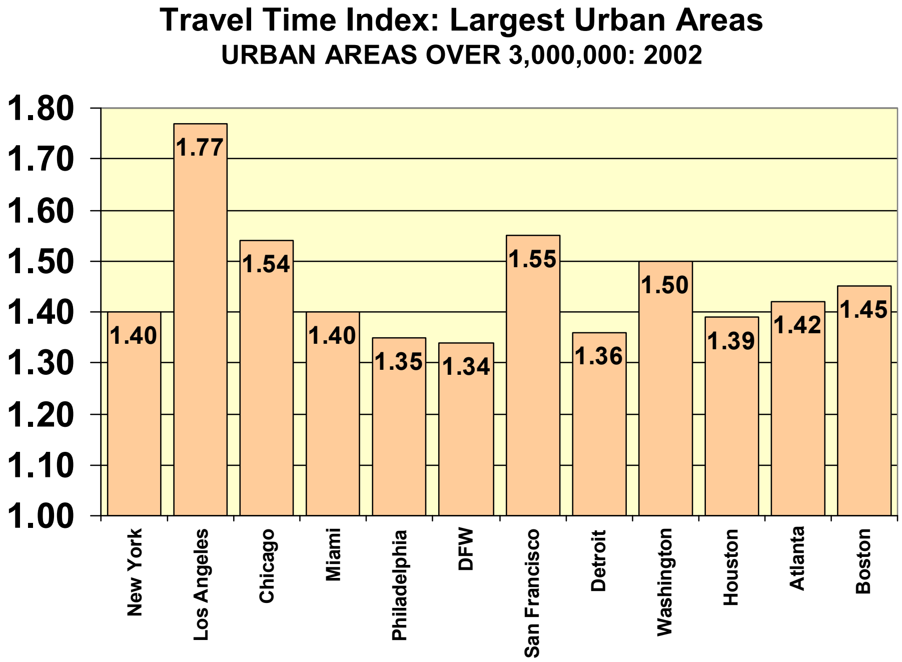
[1] This analysis is based upon the 1982-2000 Travel Time Index trend. 2003 data indicates some deterioration in ranking by the largest Texas metropolitan areas. Texas Travel Time index values, however, remain superior to corresponding urban area size classification averages.
[2] Based upon US Census data for urbanized areas, 2000. This includes the Atlanta urbanized area, in which the US Census Bureau counted 3,500,000 residents. The Federal Highway Administration urbanized area population estimate is below 3,000,000 and has not been calibrated to reflect the Census results.
[3] Texas Transportation Institute data. The Travel Time Index (TTI) is used instead of the Texas Congestion Index (TCI) used earlier in this report, because TCI data is not available for areas outside Texas.
[4] http://www.demographia.com/db-econ-uaintl.htm. Atlanta ranks number one, Dallas-Fort Worth number three and Houston number four. City-state Singapore ranks second.

Exhibit 54:



San Antonio is the only Texas urban area among the 27 in the United States with a population between 1,000,000 and 3,000,000 ("large" urban areas). San Antonio has a Travel Time Index of 1.23, slightly below the average of 1.26 for the category. San Antonio has the 10th most favorable Travel Time Index among urban areas in the large urban area category. The highest Travel Time Index is in Denver, at 1.40 and the lowest values are found in Buffalo, at 1.08, and in Kansas City, Cleveland and Pittsburgh at 1.10.

Austin and El Paso are among the 29 urban areas with populations between 500,000 and 1,000,000 ("medium" urban areas).[5] Austin has the most congested traffic conditions in the category, as measured by a 1.31 Travel Time Index, well above the average of 1.17. El Paso ranks slightly lower than average, with a Travel Time Index of 1.14. Rochester, New York (1.06), Albany, New York (1.07) and Springfield, Massachusetts (1.07), have the least congested conditions.

The Texas Transportation Institute provides data for only 16 urbanized areas with less than 500,000 residents ("small" urban areas). Corpus Christi has the least traffic congestion in this category, with a Travel Time Index of 1.04. Three other Texas urbanized areas, Laredo, Brownsville and Beaumont, have a Travel Time Index of 1.07. The average for the 12 non-Texas small urbanized areas is 1.10. Colorado Springs has the

[5] The Austin metropolitan area has more than 1,000,000 residents. However, the urbanized area has a population less than 1,000,000. An urbanized area includes only residents living within the continuously built up area. A metropolitan area includes the entire labor market, including both the continuously built up urbanized area and other (usually rural) areas in the counties designated by the Bureau of the Census.

most traffic congestion among the urban areas reported in the category, with a Travel Time Index of 1.19.

Traffic Congestion Trend

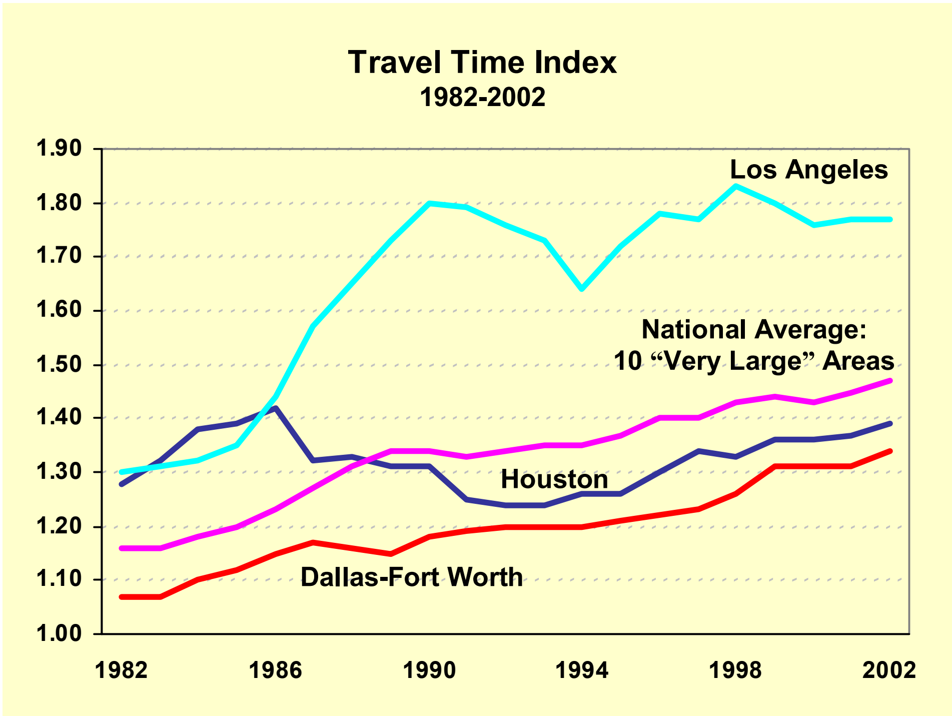
Traffic trends in two of the three largest Texas urbanized areas, Houston and San Antonio, have been generally more favorable than in the rest of the nation.

In 1982, Houston had the second highest Travel Time Index in the nation, at 1.28. This was considerably worse than the non-Texas average large urbanized average of 1.16. Houston's Travel Time Index peaked at 1.42 in 1986. From 1983 through 1985, Houston's Travel Time Index had been the worst in the nation. Houston's Travel Time Index was 12 points worse than the non-Texas average in 1982 and had fallen to nine points behind the average by 2002. A principal reason for Houston's success was that it built substantial new roadway capacity. Only slow growing Pittsburgh, Buffalo, New Orleans and Cleveland experienced smaller increases in the Travel Time Index between 1982 and 2002 among urbanized areas with more than 1,000,000 population.

In 1982, the Dallas-Fort Worth Travel Time Index was 1.07; nine points better than the 1.16 non-Texas average. By 2002, the Dallas-Fort Worth Travel Time Index was 1.34, 13 points less than the non-Texas average of 1.47. The Dallas-Fort Worth Travel Time Index increase from 1982 to 2002 was 25.2 percent, above the 20.0 average for urbanized areas over 1,000,000 population (Exhibit 55).

San Antonio experienced a lower than average 17.1 percent increase in its Travel Time Index from 1982 to 2002, ranking 13th in controlling the increase in traffic congestion.

Exhibit 55:



Traffic Congestion: The Future

There are indications that urban areas may be even less successful in controlling traffic congestion in the years to come. This results from two principal causes. Generally, highway revenues are insufficient to provide sufficient capacity to accommodate the traffic growth that virtually all metropolitan planning organizations forecast. There is also a view that additional capacity should generally not be provided.

It would therefore seem likely that traffic congestion would continue to worsen over the next quarter century, especially in urban areas that do not adopt strategies similar to the TMMP. At the same time, the improved traffic conditions that will occur if the TMMP Mobility Objectives are achieved will substantially strengthen the competitiveness of the Texas metropolitan regions.

Mobility and Access

One of the principal reasons that large urban areas have grown faster than smaller urban areas and rural areas is that they have far greater employment opportunities. Prud'homme and Lee have shown that urban labor markets are more economically productive where a larger number of jobs can be accessed within a particular period of time.[6] Their international research estimated that the economic performance of an urban area

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[6] Remy Prud'homme and Chang-Woon Lee (1998), “Size, Sprawl, Speed and the Efficiency of Cities,” Paris, France: Osbervatoire de l'Économic et des Institutions Locals.

increased 1.18 times the change in the percentage of jobs that could be reached in a fixed time, such as 30 minutes.

Other evidence can be found in comparing two nearby large urban areas that have had materially different land use and transport policies. Since World War II, the London area has been subject to strict land use policies that included development of a wide greenbelt that has forced all growth to the outside. The London area is relatively poorly served by highways, with most freeway length in the single M-25 beltway. In contrast, contiguous urbanization has been permitted in the Paris area (following the natural development pattern typical of the United States), which has also built the greater portion of three freeway standard beltways, as well as up to 12-lane freeways that connect them. Despite the strong financial core of London, data indicate that the Paris area is substantially more productive than the London area. A report commissioned by the Corporation of London found that major contributing factors were the better urban transport system of Paris, including both highways and transit.[7] The research showed that labor markets were substantially larger in Paris than in London because of higher operating speeds and greater capacity. For example, 60-minute labor markets in the Paris area average at least one-quarter more employment than in the London area. This is despite the fact that the Paris and London areas have similar average roadway speeds. Moreover, London's metropolitan area population is larger than that of Paris.[8]

Densification and Traffic Congestion

Current urban and transportation planning literature contains frequent references to attempts to use regional densification strategies[9] to reduce the length of commute trips. Texas metropolitan areas have generally not adopted regional densification strategies.

Even if such strategies were to prove successful and reduce overall trip lengths, there is the likelihood that traffic congestion would be *worsened* in the process. This is because higher population densities are associated with more intense traffic congestion. Because of the greater congestion, vehicle operating speeds tend to be lower.

The result is that total vehicle hours per square mile increases at a greater rate than vehicle miles per square mile. For example, urban areas with more than 20,000 persons

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[7] Center for Economics and Business Research, Ltd and Observatoire de l'Economie et des Instiutuions Locales University of Paris XII (1997), *Two Great Cities: A Comparison of the Economics of London and Paris.*

[8] To have equaled the size of Paris labor markets with its green belt, London could have compensated with huge highway investments, which would have made it possible for drivers to travel further in the same period of time. This alternative was not seriously considered. Generally more robust roadway systems, combined with the lower traffic intensity from lower population density, has allowed more geographically expansive urban areas in the United States to retain some of the best work trip travel times in the high-income world and correspondingly large labor markets. For example, see: http://www.publicpurpose.com/ut-intljtwtimesize.htm.

[9] Densification policies rely on regulations that ration land, such as urban growth boundaries, excessive development impact fees or large lot zoning. These policies are often referred to as "smart growth," "compact city" or "urban consolidation."

per square mile have vehicle hour traffic intensities 7.4 times that of urban areas under 3,000 (a category that included the four largest Texas urban areas in 1990). Vehicle mile intensities are lower, at 3.1 times the under 3,000 category. Urban areas between 10,000 and 19,999 persons per square mile[10] have vehicle hour traffic intensities 4.0 times that of urban areas under 3,000 (Exhibit 56).[11] This compares to a lower vehicle mile intensity of 2.4.

The 10,000 to 19,999 category includes Western European urban areas. Western European urban areas are frequently cited as examples for US urban areas to follow, especially because the automobile market share is somewhat smaller[12] and there is more transit use. Transit service intensities (transit vehicle miles per urban square mile) are more than 10 times greater in Western European urban areas than in the United States. Even so, Western European urban traffic volumes tend to be more intense than in the United States.[13] Moreover, traffic congestion tends to be worse because there are many pre-automobile roadways, and roadway capacity is smaller relative to demand.

In 1990, the five Texas urban areas had an average vehicle mile (Exhibit 57)[14] traffic intensity of 55,890, which is 13 percent above the international average of 49,432 for urbanized areas below 3,000 population density as indicated in Exhibit 56.

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[10] In 2000, the average population density of US urbanized areas over 1,000,000 population was 3,400. The Los Angeles urbanized area was the most dense, at 7,068 (1,800 more than New York). Atlanta had the lowest density at 1,783. The densities of the largest Texas urbanized areas were Dallas-Fort Worth at 2,946, Houston at 2,951, San Antonio at 3,257 and Austin at 2,835. Despite Portland's densification strategies, its density remains below average, at 3,340.

[11] Calculated from data in Kenworthy & Laube, *Cities and Automobile Dependence*, 1999. This is the latest comprehensive international data available.

[12] US automobile market shares are approximately 98 percent of the total automobile plus transit market. In large Western European urban areas, the average automobile market share is 80 percent (*Millennium Cities Database*). However, this comparison, based upon the available international data, tends to overstate transit market shares in Western Europe compared to the United States. Transit market shares tend to be lower in smaller Western European urban areas. There is no comprehensive reporting of smaller urban area data.

[13] Wendell Cox, *Public Transport Competitiveness: Implications for Emerging Urban Areas*, presentation to CODATU XI Congress, Bucharest, Romania: 2004 (http://www.publicpurpose.com/c11-icators.pdf).

[14] Vehicle hour data not available.

Exhibit 56:

Population Density and Traffic Intensity: 1990 International Urban Areas				
Density	Vehicle Mile Traffic Intensity	Average Speed	Vehicle Hour Traffic Intensity	Number of Urban Areas in Sample
20,000 & Over	153,590	15.2	11,373	7
10,000-19,999	118,000	19.3	6,187	11
5,000-9,999	98,111	24.2	4,183	10
3,000-4,999	69,510	30.0	2,340	13
Under 3,000	49,432	31.7	1,540	5
Average/Total	97,936	24.1	4,948	46
Source: Calculated from data in Kenworthy & Laube				

Exhibit 57:

Vehicle Miles per Square Mile: Largest Texas Urban Areas: 1990	
Urban Area (Density)	Vehicle Miles per Urban Area Square Mile
Austin (2,057)	46,261
Dallas-Fort Worth (2,216)	58,511
Houston (2,465)	62,851
San Antonio (2,578)	55,938
Average	55,890
Source: Calculated from Texas Transportation Institute data. 1990 data used for international comparison. 2000 density figures for each urban area are higher. This is apparently the result of Bureau of the Census definitional changes that now exclude rural areas of municipalities in an urbanized area.	

Higher densities are also associated with higher Travel Time Index values (slower travel) in US urban areas. Among urban areas with densities above 4,000, the Travel Time Index averages 1.51, while urban areas below 2,000 density average 1.23 (Exhibit 59). Further, research for the United States Department of Transportation indicates that traffic volumes increase with density. The data indicates that areas with double the average urban density in the United States have traffic volumes (vehicle miles) that are approximately 1.9 times as great[15] (Exhibit 58).

Further, the more intense local traffic volumes produced by higher density combined with the resulting slower speeds tends to increase local area air pollution emissions. Generally, the principal vehicle pollutants tend to be associated with slower speeds and especially with the "stop and start" travel conditions that are typical of more intense traffic.

[15] Calculated from US Census Bureau data and Catherine E. Ross and Anne E. Dunning, "Land Use and Transportation Interaction: An Examination of the 1995 NPTS Data," *Searching for Solutions: Nationwide Personal Transportation Survey Symposium*, US Federal Highway Administration, October 29-31, 1997.

Exhibit 58:

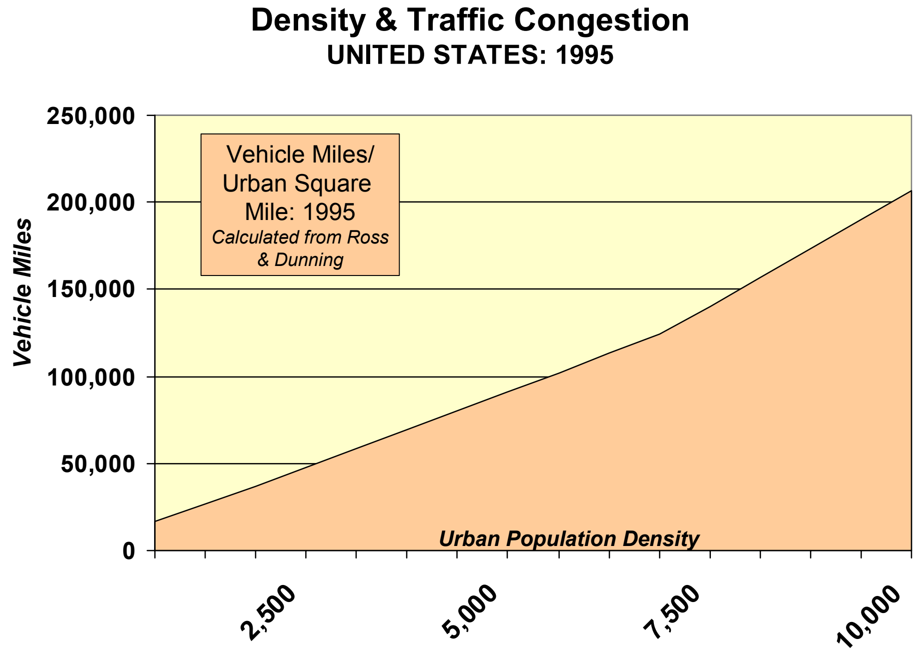


Exhibit 59:

Travel Time Index (TTI) By Population Density: 2000	
Density (Population per Square Mile)	TTI
4,000 & Over	1.51
3,000-3,999	1.39
2,000-2,999	1.32
Under 2,000	1.23
Source: Calculated for U.S. urban areas over 1,000,000 population from Texas Transportation Institute *2002 Urban Mobility Report*	

Adoption of Mobility Objectives is, thus far, unique to Texas. Other states could follow Texas, but it is also likely that many will not. Traffic conditions are likely to be considerably better in Texas metropolitan areas than elsewhere in the United States. The shorter travel times and greater amounts of leisure time that occurs with less intense traffic congestion are likely to improve the quality of life in Texas relative to the rest of the nation.

SECTION VII
Competitiveness and Housing Affordability

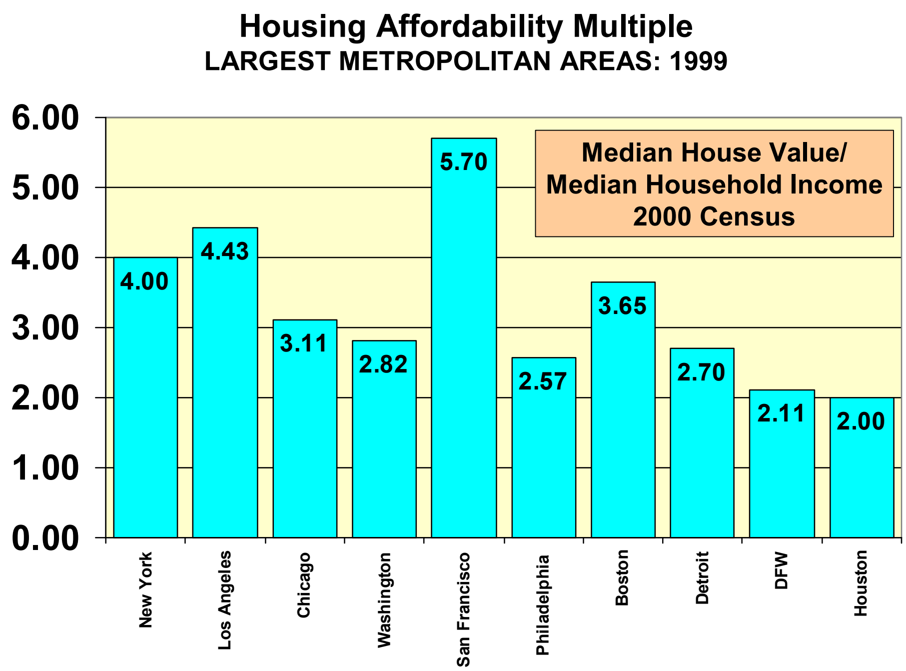
In addition to having generally favorable traffic conditions, Texas metropolitan areas have among the best housing affordability in the nation. Continuing improvement of the roadway system can be expected to support the continuation of this housing affordability. This will ensure that lower cost housing that is built on less expensive land on the urban fringe has better access to employment and shopping throughout the urban area.

Greater housing affordability is important for attracting new businesses to the state. Generally, greater housing affordability leads to higher home ownership rates, and greater accumulation of savings through house equity. Home ownership is a particularly important strategy for transitioning lower income households, who are disproportionately minority, into the economic mainstream.

According to the 2000 US Census,[1] Dallas-Fort Worth and Houston were, by far, the most affordable housing markets among the 10 largest metropolitan areas[2] in the nation. In Dallas-Fort Worth, the nation's 9th largest metropolitan area, the median house value was 2.11 times the median household income. Houston, the 10th largest metropolitan area, had even more affordable housing, with a median house value to median household income ratio (housing affordability multiple) of 2.00. By comparison, the housing cost ratio averaged 3.62 among the largest metropolitan areas. If Dallas-Fort Worth costs were as high as the other large metropolitan average, housing prices would been have been 72 percent more in 1999. In Houston, the other-metropolitan average would have raised housing prices 81 percent (Exhibit 60).

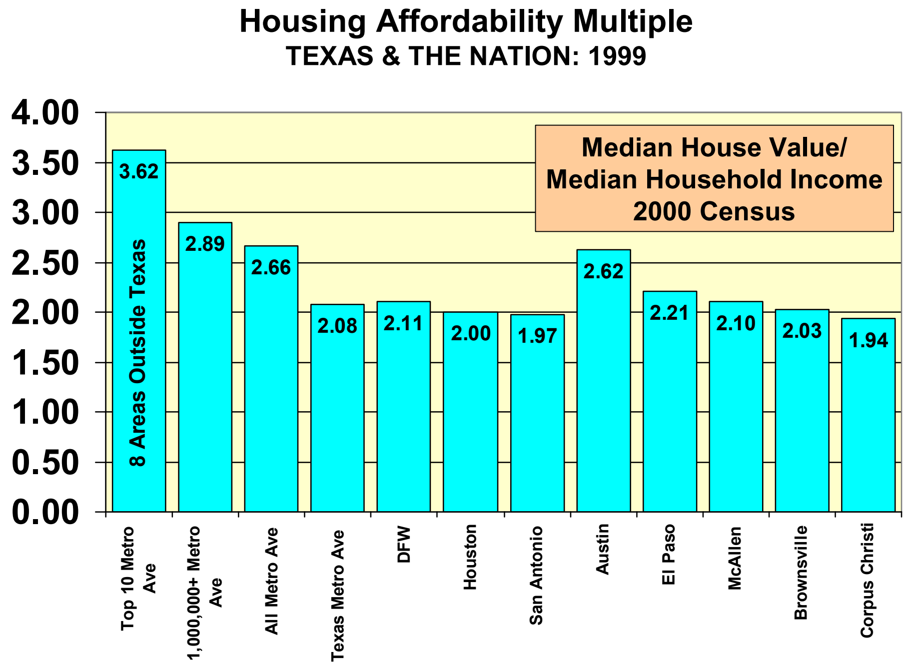
[1] Data is for 1999.
[2] Consolidated metropolitan statistical areas or metropolitan statistical areas.

Exhibit 60:



The superiority of housing affordability in Dallas-Fort Worth and Houston is illustrated by the following comparisons. Housing was more affordable in Dallas-Fort Worth than in any of the nation's 58 largest metropolitan areas except for Houston. Houston's housing affordability was better than in any of the nations 76 largest metropolitan areas (Exhibit 61).

Exhibit 61:



The only larger metropolitan area in the state with a near-national average housing affordability multiple is Austin, at 2.62 (Exhibit 61). This is somewhat below the 2.89 average for metropolitan areas above 1,000,000 population.

Other Texas metropolitan areas also have superior housing affordability. San Antonio had a median housing affordability multiple of 1.97, the best among the 49 metropolitan areas in the nation with more than 1,000,000 population. This is considerably more affordable than the over 1,000,000 population average, which was a 2.83 median housing affordability multiple. The average median housing affordability multiple was 47 percent higher among these metropolitan areas than in San Antonio.

Virtually all other larger metropolitan areas had a median housing affordability multiple well below the national average. El Paso had a housing affordability multiple of 2.21, McAllen at 2.10, Brownsville at 2.03, and Corpus Christi at 1.94. Beaumont had the second lowest median housing affordability multiple among the nation's 276 metropolitan areas at 1.75. Smaller Midland-Odessa, at 1.70, had the lowest median housing affordability multiple of any metropolitan area in the nation in 1999.

Overall, including both larger and smaller metropolitan areas, Texas had a median housing affordability multiple of 2.08, well below the average of 2.66 for all 276 metropolitan areas. (Exhibit 61) Texas's strong performance in housing affordability is particularly noteworthy because of its strong growth. As was noted above, Dallas-Fort Worth and Houston are among the four fastest growing large metropolitan areas in the high-income world. Such high demand might be expected to drive prices higher. However, the market has been able to supply enough new housing to keep housing prices from rising materially. Data that are more recent underscore the Texas competitive position even more significantly. Over the past five years, National Association of Realtors market data indicate an increase of approximately 60 percent in house prices. In the Dallas market, the increase has been a much lower 22 percent, and 32 percent in Houston. By comparison, markets with a greater problem of land scarcity (such as the larger California urban areas, West Palm Beach, Fort Lauderdale and the Boston suburbs) have experienced increases of from 100 percent to 140 percent. Over the same period, median family incomes have risen 17.5 percent.[3]

Housing costs have risen around the nation relative to incomes, as would be expected with the historically low interest rates that have characterized recent years. Data from the Bureau of the Census American Community Survey indicate that the national housing affordability multiple rose 21 percent from 1999 to 2004. Texas remained more affordable, with an increase of 12 percent. Texas became the third most affordable state, compared to having ranked fourth in 1999.

The American Community Survey provides data for some metropolitan areas, including Dallas-Fort Worth but not Houston. However, the Dallas-Fort Worth housing cost escalation has been considerably lower than in San Francisco and Boston. The Dallas-Fort Worth housing affordability multiple was reported at 2.66 in 2004, up 26 percent from 1999. This is considerably less than in San Francisco or Boston. San Francisco's housing affordability multiple rose to 8.60, an increase of 51 percent. Boston's housing affordability multiple rose to 5.72, an increase of 57 percent. Both San Francisco and Boston rely heavily on land rationing policies.[4]

If the housing affordability multiple in Dallas-Fort Worth were as high as in Boston, average annual mortgage payment would be $10,700 higher than at present. If the Dallas-Fort Worth housing affordability multiple were at the San Francisco level, average annual mortgage payments would be $20,700 higher than at present (Exhibit 62).[5] The 2004 median house value in Dallas-Fort Worth was $129,000. At the Boston housing affordability multiple, the Dallas-Fort Worth median house value would have been 115 percent higher, at $278,000. At the San Francisco housing affordability multiple, the Dallas-Fort Worth median house value would have been 223 percent higher, at $418,000 (Exhibit 63).

[3] House price data calculated from www.realtor.org (National Association of Realtors) data.

[4] The San Francisco area relies on urban growth boundaries and other land regulations. Boston uses large lot zoning.

[5] Assumes that all of the higher house value would be mortgaged, at a six percent annual mortgage rate.

Exhibit 62:

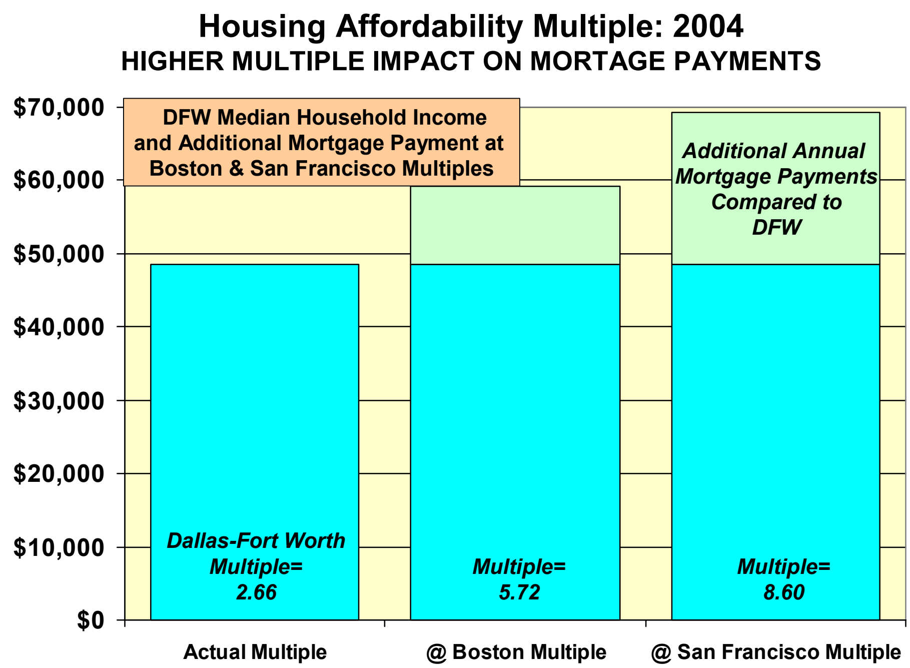
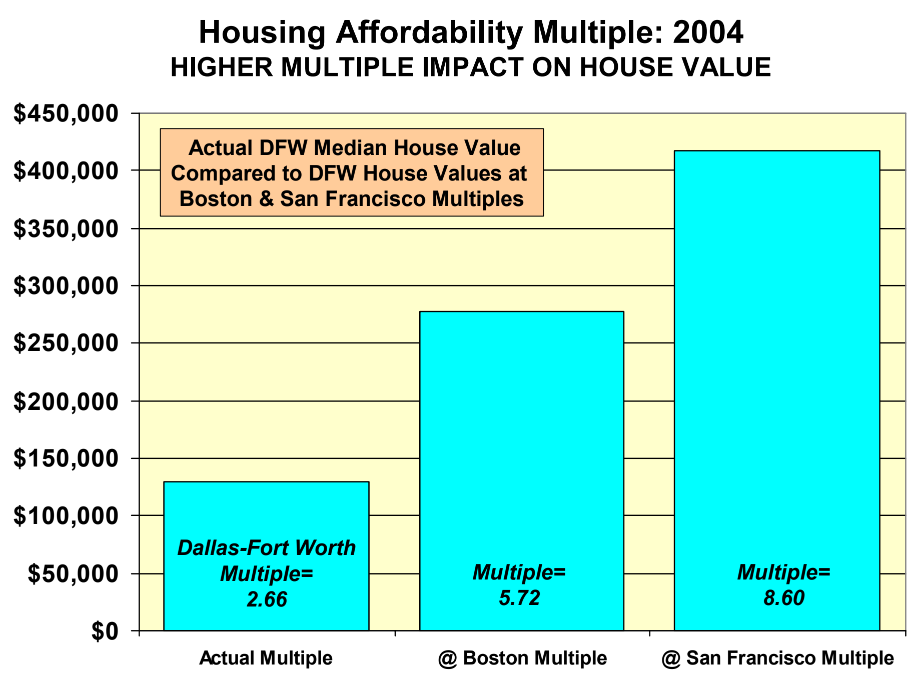


Exhibit 63:



Maintaining Competitiveness in Housing Affordability

In a nation of comparatively ubiquitous national markets, most cost of living categories vary little within or between regions. Housing costs, however, are highly variable between metropolitan areas and represent the most significant cost of living difference between metropolitan areas. Data from ACCRA, the leading source for comparative cost of living information,[6] indicate that two-thirds of the variation in large US metropolitan area costs of living is attributable to housing costs differentials.[7]

There is a growing body of evidence that metropolitan housing cost variations are related to more aggressive land use regulation, especially through densification policies that ration land development (urban consolidation policies). The problem is fundamental to economics. If the supply of a good or service is restricted, prices will tend to rise. This might occur because of natural shortages (such as in precious metals, such as gold) or because of public policies.

In recent years, land rationing policies have been implemented in a number of urban areas in both the United States and abroad. A principal strategy has been to ration land for residential and commercial development through urban growth boundaries, green belts or designated “growth areas” and imposing development impact fees on new houses. The economic dynamics and the research would seem to predict an upward impact on housing prices. That has occurred, both in the United States and internationally.

The 11 US urbanized areas with over 1,000,000 population that are subject to land rationing policies had a housing affordability multiple of 4.11, well above the 2.74 for the 26 areas that had not adopted such policies.[8] If the housing affordability multiple from the land-rationing metropolitan areas were applied to Dallas-Fort Worth or Houston, the median priced house would have been $90,000 to $95,000 more expensive in 1999.

Moreover, since 1970, before land rationing policies were adopted, the largest housing affordability losses have occurred in states that have adopted such policies (Oregon, California, Washington, and Colorado).[9]

Edward Glaeser of the John F. Kennedy School of Government at Harvard University and Joseph Gyourko of the Wharton School at the University of Pennsylvania indicate that housing affordability between metropolitan areas is significantly reduced by more stringent land use regulation. They concluded, “zoning and other land use controls play the dominant role in making housing expensive.[10] More stringent land use regulation rations both land and development and raises prices.

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[6] Data from www.accra.org.
[7] Housing costs are estimated by ACCRA to be 28 percent of overall household costs.
[8] http://www.demographia.com/db-housemult-smg.htm.
[9] Massachusetts lost more housing affordability than Colorado. The housing scarcity problem in Massachusetts has not been urban consolidation policies, but rather the preponderance of large lot zoning.
[10] Edward L. Glaeser and Joseph Gyourko (2002). *The Impact of Zoning on Housing Affordability*, Cambridge, MA: Harvard Institute of Economic Research.

A report by the United States Department of Housing and Urban Development found that:

> *A number of communities, however, have used smart growth rhetoric to justify restricting growth and limiting developable land supply, which lead to housing cost increases.*[11]

This is consistent with the international results of land rationing policies. In the United Kingdom, land rationing policies were adopted in the late 1940s, and virtually all new housing and commercial development has been forced into constrained areas as defined by planning authorities. From 1971 to 2001, average house prices increased 2.4 percent annually, more than double the 1.1 percent rate in Europe, where land use regulation is considerable, but far less restrictive than in the United Kingdom.[12] According to the recent Barker report, prepared for Deputy Prime Minister John Prescott, planning regulation that rations land is the "main" reason for the nation's housing shortage and housing affordability crisis. This is a particularly striking conclusion for a Labour government, which is considered generally supportive or current urban planning strategies.

A similar situation has arisen in Sydney, Australia, where government policy has rationed land for development over the past five years perhaps more stringently than in any other high-income world urban area. Housing affordability has been driven down substantially.[13] It is now estimated that the average house price is nearly 10 times median household income, nearly double the 1996 ratio, three times the US ratio and more than four times the Dallas-Fort Worth and Houston ratios. Land rationing policies have been adopted in nearly all of the most unaffordable housing markets in the United States, Canada, Australia and New Zealand.[14]

New research indicates land use regulations are leading to lower levels of economic growth. A paper by Raven Saks, published by the JFK School of Government at Harvard concluded:

> *metropolitan areas with stringent development regulations generate less employment growth than expected given their industrial bases*[15]

The higher housing costs that occur with land rationing have important social implications. They make it more difficult for younger households to purchase their first homes. As a result, it is likely that higher housing affordability multiples will lead to lower rates of home ownership. This could have serious longer-term economic impacts, since approximately one-half of middle-income wealth is in house equity.[16] Further, a significant minority home ownership gap remains.

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[11] US Department of Housing and Urban Development, *Why Not in Our Community? Removing Barriers to Affordable Housing* (February 2005).

[12] Kate Barker (2004). *Review of Housing Supply: Delivering Stability: Securing Our Future Housing Needs: Final Report—Recommendations.* Norwich, England: Her Majesty's Stationery Office. Internet: http://www.hmtreasury.gov.uk/consultations_and_legislation/barker/consult_barker_index.cfm .

[13] Craig Johnston (2003). Land Supply and Housing Affordability in Sydney. Sydney, Australia: Shelter New South Wales. Internet: http://www.housing.infoxchange.net.au/library/ahin/housing_partnerships/items/00012-upload-00001.pdf .

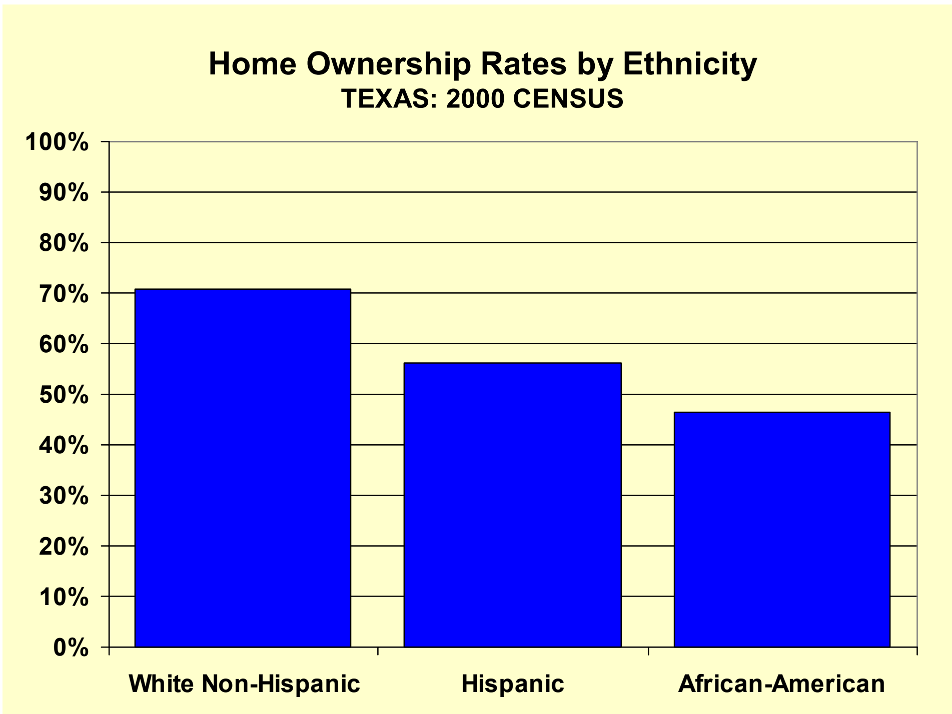
[14] http://www.demographia.com/dhi-200502.htm.

[15] http://www.jchs.harvard.edu/publications/markets/w04-10_saks.pdf.

[16] ###

In Texas, 70.8 percent of White-Non-Hispanic households owned their own homes, according to the 2000 Census. The Texas Hispanic home ownership rate was one-fifth lower, at 56.1 percent. The African-American home ownership rate was even lower, more than one-third below the White-Non-Hispanic rate, at 46.5 percent (Exhibit 64). Policies that ration land are likely to result in even lower minority home ownership rates, which is in direct conflict with the policy imperative to raise minority home ownership rates.

Exhibit 64:



The favorable experience of the Texas metropolitan areas (and the experience of other areas before or without land rationing) shows that the home building industry produces sufficient housing unless there is some outside restriction. Metropolitan areas in Texas can be expected to maintain their superior housing affordability because of land use policies that generally exclude regional densification strategies. This should reinforce the already strong competitive position of Texas in the future, making the state more attractive for business expansion and new business location.

SECTION VIII
Freight

Introduction

Trucks are an integral component of the U.S. economy. Large trucks currently account for approximately 75 percent of all domestic freight tonnage and more than one-quarter of ton miles.[1] Trucks are estimated to carry 60 percent of freight tonnage in Texas.

At the same time, trucks represent significant challenges for the roadway system. Their weights tend to be many times that of cars and, as a result, roadway systems require more frequent refurbishment and rebuilding.

The Texas truck fleet has grown dramatically in recent years, and has been shifting toward larger vehicles. The in-state commercial truck fleet, excluding small pick-ups and personal use trucks, grew by 20 percent from 1997 to 2002, most of which reported operating primarily within the state. Most of the growth occurred in high-mileage, for-hire and warehousing vehicles. About 20 percent of the five-year growth was in large combination truck tractors.[2]

The Federal Highway Administration projected that truck traffic would increase nearly 75 percent from 1998 to 2020 in the nation. At this annual rate, Texas large truck traffic would more than double in the next quarter century. However, the challenges could be even greater. FHWA projects urban freeway large truck volumes to rise approximately one-third more than the overall increase in truck traffic at the national level. Based upon these figures, Texas urban areas could be facing a 125 percent increase in large truck traffic on freeways over the next 25 years. With the strong Texas growth rate and the state's pivotal position with respect to international (North American Free Trade Agreement) trade, even these projections could be conservative.

Personal vehicle (automobile and sport-utility-vehicle) traffic is rising more slowly. Metropolitan Planning Organizations in the state are projecting personal vehicle travel increases at or slightly above the population growth rate. This would mean that overall personal vehicle travel volumes in Texas urban areas would increase approximately 50 percent in the next 25 years. By comparison, truck traffic, as estimated above, could increase at 2.5 times the personal vehicle rate.

Thus, truck traffic will become a larger share of overall traffic counts. Nevertheless, because of their larger size, the continuing increase in large truck traffic will be even more challenging for a roadway system already facing serious capacity constraints. In 1999, it was estimated that large trucks represented 4.6 percent of urban freeway traffic in Texas. At the growth rates estimated above, the truck share of urban freeway traffic would increase to 7.3 percent in 2030.

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[1] The lower percentage of ton-miles indicates the shorter average distance typical of truck shipments.
[2] Light-heavy vehicles are between 19,500-26,000 lbs and heavy-heavy are above 26,000 lbs. All data from the 2002 Vehicle Inventory and Use Survey of the US Bureau of the Census.

Border urbanized areas are likely to face particularly intensive challenges. El Paso, Laredo, McAllen and Brownsville are likely to experience strong increases in truck traffic as North American Free Trade Agreement commerce grows. Substantial investments have brought significant improvements in truck movements through Laredo. It is likely that other projects will be required to maintain acceptable traffic flow levels in other border urbanized areas.

Just in flows from Mexico to Texas, truck tonnage has grown 25 percent between 1996 and 2002, and the value of freight has grown by almost two-thirds (Exhibit 65).

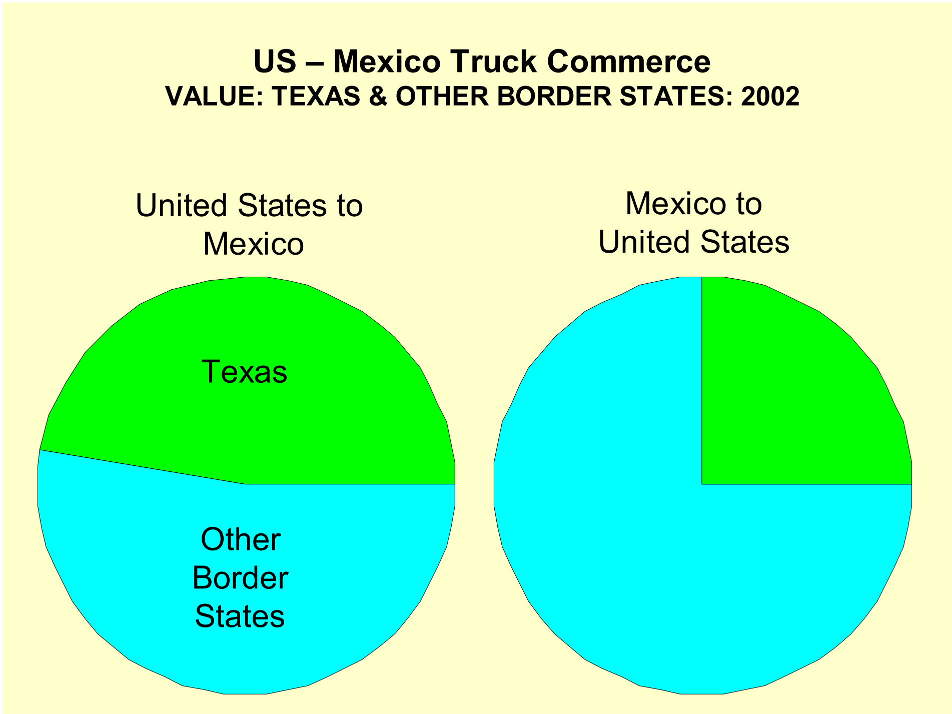
Exhibit 65:

Texas-Mexico Cross Border Truck Commerce			
	1996	2002	Change
Tons (Millions)	5.7	7.2	26.3%
Value (Billions	$13.8	$22.8	65.2%
Source: Border Trade Statistics, US Bureau of Transportation Statistics			

Trade between Texas alone to Mexico has aggregated over $337 billion dollars, 90 percent of it by truck, since data began collection in 1994, growing by approximately 70 percent in that time period. In 2002, nearly one-half of Mexico to the United States truck commerce crossed the border in Texas. Approximately one-quarter of United States to Mexico truck commerce crossed in Texas (Exhibit 66).[1]

[1] Calculated from Border Trade Statistics, US Bureau of Transportation Statistics.

Exhibit 66:



Truck Data Planning Requirements

In light of the importance of trucks to both the economy and the roadway system, consistent and periodic detailed truck data is required. Valuable data is provided by FHWA, but more frequent and localized information needs to be available. At a minimum, classification data on the share of vehicle miles by the truck fleet on each of the major freeway segments of the state system is required. In addition, assessments of the characteristics of freight flow within the state in terms of commodities carried, and the geography of the movements is central to long-range understanding of investment needs. The preceding discussion has demonstrated how the need exists for data in four sectors: intra-state freight flows; inter-state flows in to and out of the state; through volumes of Interstate traffic; as well as international flows. More comprehensive data and projections on trucks would assist planners in identifying the extent of improvements needed to accommodate rising truck volumes and strategies to use existing or other resources more effectively.

TXDOT and the MPOs should undertake a program to produce annual truck volume information for urbanized areas, especially on major freeway segments. In addition, large truck volumes should be projected over a 25-year period. At least this level of information is required to adequately plan for future demand.

Strategies

A number of strategies would be available to expedite freight movement, should the planning process identify extraordinary needs. For example:

- Exclusive truck roadways could be built. These might be new roadways or new lanes on existing roadways. Often, tolls are suggested to finance exclusive truck roadways. However, caution should be employed with respect to proposals for truck tollways. For example, there is hope that the SH 130 toll road being built to bypass Austin will substantially reduce large truck traffic on highly congested I-35 through the center of Austin. This case should be closely monitored. The time savings produced by SH 130 may not be economically sufficient to many truckers to justify the toll. The fact that some truck labor compensation is based upon mileage rather than time could militate against transferring some traffic to SH 130. If the truck diversion rates fall below expectations, consideration might be given to tolling I-35 for trucks and allowing trucks to use SH 130 without tolls (while cars would still pay tolls). Of course, any facilities that would require non-user (toll or other) finance would need to be subjected to the same cost benefit analysis as applies to other Texas Metropolitan Mobility Plan criteria.

- Targeted intermodal improvement. There may be opportunities in some corridors to transfer truck container freight to railroads. A model may be provided by Los Angeles, where the railroad right-of-way leading to the ports of Los Angeles and Long Beach has been depressed (Alameda Corridor Project). This speeds the operation of container trains, and reduces traffic congestion by eliminating grade crossings for a distance of approximately 20 miles. There has already been discussion of a similar project to serve the port of Houston. State and metropolitan officials should actively encourage cooperation between trucking and railroad companies to identify strategies to improve highway safety, traffic congestion and air pollution.

At the same time, any specialized truck or freight strategies or facilities that would require non-user (toll or other) finance should be subjected to the same cost benefit analysis as applies to other Texas Metropolitan Mobility Plan criteria.

Truck Safety

Substantial progress has been made in improving highway safety in recent decades. This has occurred for a number of reasons, such as efforts to reduce impaired driving, passenger restraints (seat belts), highway design and the larger percentage of travel that is occurring on higher quality roadways, especially controlled access freeways. From 1962 to 2002, highway fatality rates dropped approximately 70 percent in the United States.[1] Freeways tend to be considerably safer than other roadways. In 2002, the fatality rate on freeways was less than one-half that of other roadways.

[1] Fatalities per 100,000,000 vehicle miles. Calculated from Federal Highway Administration data.

As noted above, the average truck consumes considerably more road space of an automobile. This size, combined with greater weight, creates the potential for a disproportionate safety risk. The rate of improvement among heavy trucks has been greater than that of passenger vehicles, although the level still remains higher at 2.1 crashes per 100 million vehicle miles compared to 1.7 for passenger cars.[1] However, measured on an individual level, trucks are involved in more than 400 fatal accidents and 3,000 injury accidents in Texas each year. There is thus an understandable interest in continuing to improve truck safety.

The key to better state level truck safety data will be in establishing the correct denominator of the equation – total vehicle miles traveled by truck by type of facility, coupled with improved fatality and crash information can provide guidance to better facility design and ameliorative actions. As automated toll systems become more pervasive, the data they produce can be a very effective contributor to improved analysis.

In the longer run, truck safety is likely to be improved by continuing to expand the freeway system, so that a larger share of truck traffic is on these safer roadways. Development of special truck lanes could also improve truck safety.

[1] National Center for Safety Statistics, NHTSA, 2003 fact book.

APPENDIX I
Texas Congestion Index Calculation Overview

The Texas Congestion Index is both a performance measure and a set of techniques and procedures. The measure provides information about both person and freight movement and illustrates the effect of most of the urban transportation improvement actions and land use pattern changes. The index is relatively easy to compute, understand and communicate to a wide variety of audiences, and is similar in concept to the Travel Time Index used in the annual Urban Mobility Report from the Texas Transportation Institute[1]. Measures similar to the TCI can be used as one element of a project or corridor evaluation and prioritization process.

The Texas Congestion Index methodology was applied to the eight largest Texas metropolitan areas in the Texas Metropolitan Mobility Plan, a long-range vision-oriented planning and funding process. The Index evaluates the programs and strategies that are pursued to accomplish mobility objectives.

An Excel-based spreadsheet has been developed to use the long-range planning model program output and calculate the congestion performance measure. The travel models include roadway links labeled according to the type of development (area type) and the county where the road is located. The basic structure of the spreadsheet program is identified in Exhibit A-1 and described below.

1. The long-range travel model statistics—vehicle-hours of travel, vehicle miles of travel, average weighted free-flow and congested speeds—are produced for each road class and grouped into approximately five area types in most regional travel models.

2. The hours of travel in free-flow conditions are calculated as the baseline comparison condition for freeways, tollways, high-occupancy vehicle lanes, major streets and frontage roads.

3. Recurring delay is calculated as the difference between the congested speeds and the free-flow speeds for both truck travel and person travel.

4. Delay due to crashes and vehicle breakdowns is estimated and added to the recurring (or "good condition day") data produced by the planning models. This improves the estimates of the actual conditions faced by motorists by adding delay due to traffic collisions and vehicle breakdowns. It also allows the evaluation of treatments that reduce incident delay, but may not have a substantial effect on general capacity conditions. Initial total delay is the sum of incident and recurring delay.

[1] *The 2005 Urban Mobility Report.* The Texas Transportation Institute, College Station, Texas, May 2005. Available at: http://mobility.tamu.edu

5. The delay reducing effect of the four operational treatments listed below are not included in the long-range transportation planning model and the spreadsheet calculates an estimate of each contribution to improved mobility.

   - Arterial Street Signal Coordination
   - Arterial Street Access Management
   - Freeway Entrance Ramp Metering
   - Freeway Incident Management

6. The delay reduction due to operational treatments is totaled.

7. Total delay is estimated as the sum of incident and recurring delay minus the operational treatment benefits.

8. Vehicle travel time is calculated for passenger vehicles and trucks as the sum of free-flow travel and delay.

9. Person travel time statistics are estimated using the best estimate of vehicle occupancy rates.

10. The congested speeds, miles and hours of travel time are summarized for the morning peak (6 a.m. to 9 a.m.) and evening peak (4 p.m. to 7 p.m.) periods for truck and car travel conditions.

11. Travel miles and hours on public transportation systems and high-occupancy vehicle elanes are added to the roadway statistics.

12. The average Texas Congestion Index and other performance measures are calculated using the hourly congestion statistics for each metropolitan area. The car and truck travel time and delay statistics are combined using the hourly value of travel for each. The metropolitan area statistics are combined into one statewide Texas Congestion Index value.

Exhibit A-1. Calculation Process

For each Metro County and Year
Peak Periods (6A-9A and 4P-7P)
Person Travel Condition

1 & 2 — Vehicle Miles and Hours of Travel & Free-flow Travel (comparison condition)

3 — Recurring Travel Delay

4 — Add Incident Delay (Incident + Recurring = Total Delay)

5 — Delay reduction due to operational treatments:
Freeway Incident Management and Ramp Metering
Street Traffic Signal Coordination and Access Management
Sum these to get Delay Reductions.

6 & 7 — Adjusted delay with operational treatment effect

$\text{Delay}_{\text{OPS}} = \textit{Delay}_{\textit{TOTAL}} - \textit{Delay}_{\textit{REDUCTIONS}}$

8 — Estimate Total Vehicle Travel Time

$\text{Travel Time}_{\text{VEHICLE}} = \textit{Delay}_{\textit{OPS}} + \textit{Free-flow Travel Time}$

9 — Estimate Person Travel Time

$\text{Person TT} = \textit{TT}_{\textit{VEHICLE}} \times \textit{Person per Vehicle}$

10 — Sum the hourly Person Travel Time

11 — Include Public Transportation and HOV Lane Travel (Miles and Hours)

12 — Calculate peak period Texas Congestion Index for each metro region.
Statewide TCI is the sum of all metro travel time divided by sum of free-flow travel time.

APPENDIX II
Emissions Estimation Methodology

The following points describe the assumptions and procedures used to derive the emissions rates and their use in preparing an Emissions Index for use in comparing emissions impacts of alternative TMMP networks[1].

- Nitrogen oxides (NOx) and volatile organic compound (VOC) emissions rates are provided for 2000 and 2025 morning and evening peak periods, applicable to peak traffic periods in each of the eight Texas transportation management areas (TMAs) included in the TMMP effort.

- The process develops an Emissions Index for the morning and evening peak periods. This index provides a relatively quick estimate of the effect of the transportation investments on emissions levels relative to the 2000 estimates. It does not replace the type of air quality analysis already being performed. This technique is only designed to provide "ballpark" estimates of the effects.

- The Texas Congestion Index spreadsheet will be used to calculate the tons of peak period emissions for each year. These outputs for each year will be used to create a morning and evening peak period emissions index. The peak periods include travel for 6 to 9 a.m. and 4 to 7 p.m.

- Order of magnitude peak period emissions can be generated using vehicle-miles of travel by functional classification for each of the eight urbanized area transportation networks. The NOx and VOC emissions rates are added and then used to estimate the amount of annual emissions. The combined Emissions Index is calculated by dividing estimated emissions for a given year by the emissions for 2000. This will provide an indication of the change in emissions that might result from the modeled transportation system. For example,

  $$I_{2025} = (E_{voc2025} + E_{nox2025})/(E_{voc2000} + E_{nox2000}),$$

  where

  I_{2025} is the combined emissions index for 2025,

  $E_{voc2025}$ is the estimated VOC emissions for peak periods in 2025, etc.

- Morning and evening peak period vehicle-miles of travel are needed for freeway and arterial functional classifications (rates are based on MOBILE6 data for 7-8 am and 5-6 pm).

- Vehicle fleet mix is for the TxDOT District in which each TMA is located.

[1] Perkinson, D.G., B.S. Bochner, M. Boardman and T. Qu. Developing an Emissions Index for the Texas Metropolitan Mobility Plan. Texas Transportation Institute, College Station, TX, April 2004

- Travel speeds are based on the Dallas speed model (a function of volume to capacity ratio and coded free-flowing speed). These speeds are calculated within the Texas Congestion Index spreadsheet.

- MOBILE6 setups are the same as used for emissions inventories in the respective areas except TxDOT District level input parameters are used.

- Data provided for each network condition will be used to create an Index value. Expected conditions are:
  - 2000 base line
  - 2025 no-build (using the 2000 system)
  - 2025 financially constrained metropolitan transportation plan (MTP)
  - 2025 TMMP Needs (all MTP capacity deficiencies alleviated to target level of congestion)

APPENDIX III
Katy Freeway (I-10 West, Houston)
Analysis of Accelerated Construction Schedule

The delay and fuel consumption benefits were estimated from historic volume and travel time trends and estimates of the effect of greatly increasing capacity in the Katy Freeway corridor. Exhibit A-2 illustrates the daily traffic volume growth estimated for four segments of the Katy corridor in the accelerated and traditional construction phasing programs. The capacity expansion causes traffic that uses other roads to return to the Katy Freeway mainlanes in the opening year of the widened freeway (2009 for the current plan and 2015 for the traditional plan).

Exhibit A-2: Estimated Daily Traffic Volume for Current and Traditional Construction Plans

Current Plan	Year					
	2003	2009*	2009**	2015	2020	2028
Katy to Barker Cypress	108,000	128,960	128,960	153,980	174,220	212,270
Barker Cypress to Sam Houston Tollway	198,000	229,620	252,580	284,450	314,050	353,780
Sam Houston Tollway to I-610	240,000	270,280	297,310	325,100	350,210	379,240
I-610 to Downtown	216,000	236,180	247,990	263,250	276,680	299,610

Traditional Construction Phasing	Year					
	2003	2009	2015*	2015**	2020	2028
Katy to Barker Cypress	108,000	128,960	153,982	153,980	174,220	212,270
Barker Cypress to Sam Houston Tollway	198,000	229,620	258,598	284,450	314,050	353,780
Sam Houston Tollway to I-610	240,000	270,280	295,545	325,100	350,210	379,240
I-610 to Downtown	216,000	236,180	250,723	263,250	276,680	299,610

** -- Before the opening of the improved freeway.*
*** -- After the opening of the improved freeway.*

The travel time and speed analyses are based on estimates of the traffic volume per lane on the mainlanes and managed lanes (toll lanes). Exhibit A-3 presents the number of lanes in each configuration. The analysis assumes the same facility is built under either construction phasing.

Exhibit A-3: Number of Lanes Used in Analysis

Katy Freeway Section	Number of Mainlanes		No. of HOV or Managed Lanes	
	Current	Future	Current	Future
Katy to Barker Cypress	6	8	0	2
Barker Cypress to Sam Houston Tollway	6	8	1	4
Sam Houston Tollway to I-610	6/8	8	1	4
I-610 to Downtown	10	10	0	2

Traffic volumes were divided into daytime and nighttime conditions, with 72 percent of the daily traffic assigned to the daytime period, based on recent trends. Estimates of the managed lane conditions were based on the assumption that the price for travel in the managed lanes would be kept at the level needed to maintain free-flow conditions as well as maximizing the traffic volume on the lane to improve the toll collections. The person volume count in Exhibit A-4 includes the effect of the bus and carpool use of the managed lanes, although the effect of whatever tolls are charged for carpools is somewhat uncertain at this time.

Exhibit A-4: Average Person Volume – Daytime Period, 6 a.m. to 8 p.m.

Current Plan	Year					
	2003	2009*	2009**	2015	2020	2028
Katy to Barker Cypress						
Mainlane	77,760	92,850	83,570	99,780	106,620	125,320
Managed Lanes	0	0	9,290	11,090	18,820	27,510
Barker Cypress to Sam Houston Tollway						
Mainlane	128,300	148,790	154,580	163,840	174,110	191,040
Managed Lanes	14,250	16,530	27,280	40,960	52,010	63,680
Sam Houston Tollway to I-610						
Mainlane	138,240	155,680	160,550	168,500	176,510	185,670
Managed Lanes	34,560	38,920	53,520	65,540	75,650	87,380
I-610 to Downtown						
Mainlane	152,410	166,650	169,630	174,380	179,290	189,830
Managed Lanes	3,110	3,400	8,930	15,160	19,920	25,890

Traditional Construction Phasing	Year					
	2003	2009	2015*	2015**	2020	2028
Katy to Barker Cypress						
Mainlane	77,760	92,850	110,867	99,780	106,620	125,320
Managed Lanes	0	0	0	11,090	18,820	27,510
Barker Cypress to Sam Houston Tollway						
Mainlane	128,300	148,790	167,571	163,840	174,110	191,040
Managed Lanes	14,250	16,530	18,619	40,960	52,010	63,680
Sam Houston Tollway to I-610						
Mainlane	138,240	155,680	170,234	168,500	176,510	185,670
Managed Lanes	34,560	38,920	42,559	65,540	75,650	87,380
I-610 to Downtown						
Mainlane	152,410	166,650	176,910	174,380	179,290	189,830
Managed Lanes	3,110	3,400	3,610	15,160	19,920	25,890

** -- Before the opening of the improved freeway.*
*** -- After the opening of the improved freeway.*

Note 1: Data to calculate the number of hours of delay and the value of fuel wasted was compiled from the Urban Mobility Study database. The data was assembled for four sections of the Katy Freeway: from Katy to Barker-Cypress Road; from Barker-Cypress Road to Beltway 8; from Beltway 8 to Loop 610; and from Loop

610 to downtown. Though the Loop 610 to downtown section is not specifically considered a part of the Katy Freeway project, congestion on the Loop 610 to downtown section is favorably affected by improvement to the other sections.

Note 2: The Texas Legislature's House Research Organization estimates that Texas roadway construction costs escalated at a rate approximately 2 percentage points faster than the general rate of inflation during the 1990's. For the purposes of this report, that rate was used in the calculation of construction cost inflation during the period 2009 to 2015. See the House Research Organization, Texas House of Representatives, analysis of HB3588 (78th Regular Session) and Proposition 14 (2003) at http://capital.state.tx.us/hrofr/focus/prop78-14.pdf.

Note 3: The referenced paper can be found at http://www.fhwa.dot.gov/policy/gro98cvr.htm or a summary is available at http://www.fhwa.dot.gov/policy/empl.htm.

Note 4: Sources used in this report include the Harris County Toll Road Authority; The House Research Organization, Texas House of Representatives, the Office of Congressman John Culberson, the Office of Congressman Tom Delay, the Texas Department of Highways and Public Transportation, the Texas Transportation Institute, Urban Mobility Study, and the West Houston Organization.

APPENDIX IV
Motor Fuel Tax Calculations

Tax/Fee	Old Rate	New Rate[1]	Additional Revenue for Highways FY2007 thru FY2030	Additional Revenue for Education FY2007 thru FY2030
Motor Vehicle Registration Fee[2]	-	0.0%	$ -	-
Gasoline Tax	$ 0.20	$ 0.28	$ 106,539,274,336	$ 35,518,999,281
Diesel Fuel Tax	$ 0.20	$ 0.28	$ 44,833,187,890	$ 14,944,395,963
Total Increase in Funds FY2007 thru FY2030			**$ 151,372,462,226**	**$ 50,463,395,245**
Average Annual Increase[3]			**$ 6,581,411,401**	**$ 2,194,060,663**

$44 billion

State and Fed Tax Indexed to HCI

[1] Assumes new rates go into effect September 1, 2007.
[2] New rate represents an across the board increase in all vehicle registration fees by the percentage indicated.
[3] The additional increase in revenue for any given year will be different. Consult individual worksheets for estimates of revenue for individual years.

Needed Improvements	**44.00 Billion**

Initial Gasoline Tax Rate (cents per gallon)	**0.28**
Initial Diesel Tax Rate (cents per gallon)	**0.28**
Registration Fee Increase	**0.0%**
Annual Rate of Increase in Federal Reimbursements	**3.00%**

Initial Values

Other State Rev.:	214,900,000
Federal Transfers:	3,285,000,000

TxDOT Revenue and Expense Projections					
Year	TxDOT Revenue Total	Non-Mobility Expenses	Base Capacity	2030 Capacity	TxDOT Balance
2005	6,800,000,000	6,238,000,000	562,000,000		86,000,000,000
2006	8,004,000,000	6,488,000,000	579,000,000	938,000,000	88,951,374,888
2007	8,214,000,000	6,795,000,000	596,000,000	823,000,000	92,157,956,701
2008	8,431,000,000	7,059,000,000	614,000,000	757,000,000	95,580,174,046
2009	16,853,000,000	7,337,000,000	633,000,000	8,884,000,000	90,660,269,908
2010	16,083,000,000	8,046,000,000	652,000,000	7,385,000,000	87,082,948,349
2011	16,320,000,000	8,273,000,000	671,000,000	7,376,000,000	83,351,468,855
2012	16,563,000,000	8,588,000,000	691,000,000	7,284,000,000	79,545,577,801
2013	16,814,000,000	8,912,000,000	712,000,000	7,191,000,000	75,662,918,517
2014	17,072,000,000	9,248,000,000	733,000,000	7,091,000,000	71,707,300,919
2015	17,339,000,000	9,598,000,000	755,000,000	6,985,000,000	67,681,663,406
2016	17,613,000,000	9,962,000,000	778,000,000	6,873,000,000	63,589,078,732
2017	17,895,000,000	10,340,000,000	801,000,000	6,753,000,000	59,434,851,595
2018	18,186,000,000	10,734,000,000	825,000,000	6,627,000,000	55,222,437,802
2019	18,486,000,000	11,143,000,000	850,000,000	6,493,000,000	50,957,542,616
2020	18,794,000,000	11,568,000,000	876,000,000	6,351,000,000	46,646,132,170
2021	19,112,000,000	12,010,000,000	902,000,000	6,200,000,000	42,295,491,118
2022	19,439,000,000	12,470,000,000	929,000,000	6,041,000,000	37,912,191,470
2023	19,777,000,000	12,948,000,000	957,000,000	5,872,000,000	33,505,197,184
2024	21,124,000,000	13,444,000,000	985,000,000	6,694,000,000	28,037,112,365
2025	21,482,000,000	14,012,000,000	1,015,000,000	6,454,000,000	22,569,978,594
2026	21,850,000,000	14,547,000,000	1,045,000,000	6,258,000,000	17,057,827,504
2027	22,230,000,000	15,105,000,000	1,077,000,000	6,047,000,000	11,514,286,580
2028	21,620,000,000	15,686,000,000	1,109,000,000	4,825,000,000	6,995,147,520
2029	22,023,000,000	16,238,000,000	1,142,000,000	4,643,000,000	2,459,697,113
2030	22,438,000,000	16,868,000,000	1,177,000,000	4,393,000,000	(2,021,701,228)
TOTAL	450,562,000,000	283,657,000,000	21,666,000,000	145,238,000,000	

GBC Revenue and Expense Projections

Year	Gasoline Fuel Tax Revenues	Diesel Fuel Tax Revenues	Vehicle Registration Fee Revenues	Other State Revenues	Federal Transfers	Total Revenue	Non-Mobility Expenses	2030 Capacity	Balance
2005	1,685,890,500	528,241,500	849,231,191	214,900,000	3,285,000,000	6,563,263,191	6,238,000,000	325,263,191	44,000,000,000
2006	1,726,854,317	575,964,029	875,440,961	219,780,296	3,383,550,000	6,781,589,603	6,488,000,000	293,589,603	45,704,842,306
2007	2,570,222,368	820,119,369	902,305,773	224,782,562	3,485,056,500	8,002,486,573	6,795,000,000	1,207,486,573	46,531,952,827
2008	2,732,100,221	893,008,140	929,854,436	229,912,162	3,589,608,195	8,374,483,153	7,059,000,000	1,315,483,153	47,283,947,533
2009	2,903,987,806	971,235,268	958,145,902	235,180,073	3,697,296,441	8,765,845,491	7,337,000,000	1,428,845,491	47,951,780,728
2010	3,123,273,584	1,067,763,040	987,170,157	240,584,430	2,925,565,871	8,344,357,082	8,046,000,000	298,357,082	49,832,328,789
2011	3,361,646,194	1,173,638,162	1,016,944,753	246,128,502	3,013,994,924	8,812,352,535	8,273,000,000	539,352,535	51,546,848,300
2012	3,614,755,107	1,287,614,533	1,047,493,688	251,816,757	3,104,719,511	9,306,399,597	8,588,000,000	718,399,597	53,152,528,692
2013	3,877,359,236	1,408,001,951	1,078,795,196	257,645,141	3,197,704,805	9,819,506,329	8,912,000,000	907,506,329	54,633,873,766
2014	4,152,588,407	1,536,003,287	1,110,852,597	263,614,275	3,292,945,564	10,356,004,130	9,248,000,000	1,108,004,130	55,973,286,500
2015	4,472,156,010	1,683,700,220	1,143,616,111	269,714,887	3,390,330,355	10,959,517,584	9,598,000,000	1,361,517,584	57,108,837,438
2016	4,830,076,674	1,849,461,840	1,177,100,464	275,949,721	3,489,860,674	11,622,449,373	9,962,000,000	1,660,449,373	57,983,710,161
2017	5,229,286,924	2,035,019,366	1,211,300,054	282,317,733	3,591,534,368	12,349,458,444	10,340,000,000	2,009,458,444	58,533,618,402
2018	5,669,412,883	2,240,805,829	1,246,216,069	288,819,144	3,695,350,920	13,140,604,845	10,734,000,000	2,406,604,845	58,693,365,125
2019	6,149,862,248	2,467,110,713	1,281,882,227	295,460,233	3,801,387,653	13,995,703,074	11,143,000,000	2,852,703,074	58,393,920,482
2020	6,669,490,372	2,714,028,589	1,318,290,594	302,239,522	3,909,651,412	14,913,700,490	11,568,000,000	3,345,700,490	57,565,244,803
2021	7,231,243,604	2,983,112,905	1,355,569,839	309,180,970	4,020,423,839	15,899,531,156	12,010,000,000	3,889,531,156	56,129,981,977
2022	7,845,974,242	3,279,569,194	1,393,754,322	316,290,975	4,133,876,472	16,969,465,204	12,470,000,000	4,499,465,204	53,991,270,522
2023	8,504,711,598	3,600,276,070	1,432,862,934	323,573,054	4,250,077,475	18,111,501,132	12,948,000,000	5,163,501,132	51,060,370,318
2024	9,214,324,512	3,948,645,041	1,472,919,625	331,031,666	4,369,094,603	19,336,015,447	13,444,000,000	5,892,015,447	47,233,632,729
2025	9,977,739,155	4,326,537,011	1,513,920,477	338,666,083	4,490,938,518	20,647,801,244	14,012,000,000	6,635,801,244	42,454,126,732
2026	10,798,184,518	4,735,867,361	1,555,893,852	346,481,584	4,615,668,713	22,052,096,028	14,547,000,000	7,505,096,028	36,547,040,184
2027	11,683,865,477	5,180,874,267	1,598,860,029	354,481,947	4,743,352,352	23,561,434,071	15,105,000,000	8,456,434,071	29,375,020,986
2028	12,623,525,934	5,657,203,202	1,642,824,611	362,668,214	4,874,018,554	25,160,240,515	15,686,000,000	9,474,240,515	20,810,723,758
2029	13,635,487,219	6,173,558,198	1,687,819,580	371,046,341	5,007,741,370	26,875,652,708	16,238,000,000	10,637,652,708	10,638,224,550
2030	14,714,211,387	6,728,180,877	1,733,841,761	379,615,736	5,144,541,027	28,700,390,788	16,868,000,000	11,832,390,788	(1,248,768,294)
TOTAL	168,998,230,497	69,865,539,961	32,522,907,204	7,531,882,009	100,503,290,114	379,421,849,786	283,657,000,000	95,764,849,786	

Current Gas Tax Rate:	0.20
Future Gas Tax Rate:	0.28

Year	Historical Gasoline Tax Revenues	Current Gas Tax Rate	Future Gas Tax Rate	Current Gasoline Tax Revenues	Future Gasoline Tax Revenues	Current Tax Highway Portion of Gasoline Tax Revenue	Current Tax Education Portion of Gasoline Tax Revenue	Future Tax Highway Portion of Gasoline Tax Revenue	Future Tax Education Portion of Gasoline Tax Revenue	Gain for Highways	Gain for Education
1992	1,647,796	0.20	0.20	1,647,796,000	1,647,796,000	1,235,847,000	411,949,000	1,235,847,000	411,949,000		
1993	1,750,983	0.20	0.20	1,750,983,000	1,750,983,000	1,313,237,250	437,745,750	1,313,237,250	437,745,750		
1994	1,797,653	0.20	0.20	1,797,653,000	1,797,653,000	1,348,239,750	449,413,250	1,348,239,750	449,413,250		
1995	1,839,661	0.20	0.20	1,839,661,000	1,839,661,000	1,379,745,750	459,915,250	1,379,745,750	459,915,250		
1996	1,896,146	0.20	0.20	1,896,146,000	1,896,146,000	1,422,109,500	474,036,500	1,422,109,500	474,036,500		
1997	1,939,426	0.20	0.20	1,939,426,000	1,939,426,000	1,454,569,500	484,856,500	1,454,569,500	484,856,500		
1998	2,011,653	0.20	0.20	2,011,653,000	2,011,653,000	1,508,739,750	502,913,250	1,508,739,750	502,913,250		
1999	2,077,535	0.20	0.20	2,077,535,000	2,077,535,000	1,558,151,250	519,383,750	1,558,151,250	519,383,750		
2000	2,124,462	0.20	0.20	2,124,462,000	2,124,462,000	1,593,346,500	531,115,500	1,593,346,500	531,115,500		
2001	2,152,303	0.20	0.20	2,152,303,000	2,152,303,000	1,614,227,250	538,075,750	1,614,227,250	538,075,750		
2002	2,224,961	0.20	0.20	2,224,961,000	2,224,961,000	1,668,720,750	556,240,250	1,668,720,750	556,240,250		
2003	2,226,649	0.20	0.20	2,226,649,000	2,226,649,000	1,669,986,750	556,662,250	1,669,986,750	556,662,250		
2004	2,237,251	0.20	0.20	2,237,251,000	2,237,251,000	1,677,938,250	559,312,750	1,677,938,250	559,312,750		
2005	2,247,854	0.20	0.20	2,247,854,000	2,247,854,000	1,685,890,500	561,963,500	1,685,890,500	561,963,500		
2006	2,261,294	0.20	0.20	2,302,472,423	2,302,472,423	1,726,854,317	575,618,106	1,726,854,317	575,618,106		

Current Gas Tax Rate:	0.20
Future Gas Tax Rate:	0.28

Year	Historical Gasoline Tax Revenues	Current Gas Tax Rate	Future Gas Tax Rate	Current Gasoline Tax Revenues	Future Gasoline Tax Revenues	Current Tax Highway Portion of Gasoline Tax Revenue	Current Tax Education Portion of Gasoline Tax Revenue	Future Tax Highway Portion of Gasoline Tax Revenue	Future Tax Education Portion of Gasoline Tax Revenue	Gain for Highways	Gain for Education
2007		0.20	0.28	2,464,710,359	3,450,594,502	1,848,532,769	616,177,590	2,570,222,368	862,648,625	721,689,599	246,471,036
2008		0.20	0.29	2,507,973,362	3,642,800,294	1,880,980,021	626,993,340	2,732,100,221	910,700,074	851,120,199	283,706,733
2009		0.20	0.30	2,569,738,523	3,871,983,742	1,927,303,892	642,434,631	2,903,987,806	967,995,935	976,683,914	325,561,305
2010		0.20	0.32	2,633,104,626	4,164,364,778	1,974,828,470	658,276,157	3,123,273,584	1,041,091,195	1,148,445,114	382,815,038
2011		0.20	0.33	2,698,110,057	4,482,194,926	2,023,582,543	674,527,514	3,361,646,194	1,120,548,731	1,338,063,651	446,021,217
2012		0.20	0.35	2,764,807,253	4,819,673,476	2,073,605,439	691,201,813	3,614,755,107	1,204,918,369	1,541,149,667	513,716,556
2013		0.20	0.36	2,833,148,911	5,169,812,315	2,124,861,683	708,287,228	3,877,359,236	1,292,453,079	1,752,497,553	584,165,851
2014		0.20	0.38	2,903,142,403	5,536,784,543	2,177,356,802	725,785,601	4,152,588,407	1,384,196,136	1,975,231,605	658,410,535
2015		0.20	0.40	2,974,679,349	5,962,874,680	2,231,009,511	743,669,837	4,472,156,010	1,490,718,670	2,241,146,498	747,048,833
2016		0.20	0.42	3,047,791,958	6,440,102,232	2,285,843,968	761,947,989	4,830,076,674	1,610,025,558	2,544,232,706	848,077,569
2017		0.20	0.45	3,122,468,128	6,972,382,565	2,341,851,096	780,617,032	5,229,286,924	1,743,095,641	2,887,435,827	962,478,609
2018		0.20	0.47	3,198,710,561	7,559,217,177	2,399,032,921	799,677,640	5,669,412,883	1,889,804,294	3,270,379,962	1,090,126,654
2019		0.20	0.50	3,276,592,862	8,199,816,331	2,457,444,647	819,148,216	6,149,862,248	2,049,954,083	3,692,417,601	1,230,805,867
2020		0.20	0.53	3,356,097,848	8,892,653,830	2,517,073,386	839,024,462	6,669,490,372	2,223,163,457	4,152,416,986	1,384,138,995
2021		0.20	0.56	3,437,506,143	9,641,658,139	2,578,129,607	859,376,536	7,231,243,604	2,410,414,535	4,653,113,997	1,551,037,999
2022		0.20	0.59	3,520,892,801	10,461,298,989	2,640,669,601	880,223,200	7,845,974,242	2,615,324,747	5,205,304,641	1,735,101,547
2023		0.20	0.63	3,606,299,152	11,339,615,464	2,704,724,364	901,574,788	8,504,711,598	2,834,903,866	5,799,987,234	1,933,329,078
2024		0.20	0.67	3,693,777,557	12,285,766,016	2,770,333,167	923,444,389	9,214,324,512	3,071,441,504	6,443,991,345	2,147,997,115
2025		0.20	0.70	3,783,319,619	13,303,652,207	2,837,489,715	945,829,905	9,977,739,155	3,325,913,052	7,140,249,441	2,380,083,147
2026		0.20	0.74	3,874,987,326	14,397,579,358	2,906,240,494	968,746,831	10,798,184,518	3,599,394,839	7,891,944,024	2,630,648,008
2027		0.20	0.79	3,968,825,042	15,578,487,302	2,976,618,782	992,206,261	11,683,865,477	3,894,621,826	8,707,246,695	2,902,415,565
2028		0.20	0.83	4,064,845,134	16,831,367,912	3,048,633,850	1,016,211,283	12,623,525,934	4,207,841,978	9,574,892,084	3,191,630,695
2029		0.20	0.87	4,163,117,488	18,180,649,626	3,122,338,116	1,040,779,372	13,635,487,219	4,545,162,406	10,513,149,103	3,504,383,034
2030		0.20	0.92	4,263,635,332	19,618,948,516	3,197,726,499	1,065,908,833	14,714,211,387	4,904,737,129	11,516,484,888	3,838,828,296
	TOTAL			78,728,281,793	220,804,278,917	59,046,211,344	19,682,070,448	165,585,485,680	55,201,069,729	106,539,274,336	35,518,999,281

Current Gas Tax Rate:	0.20
Future Gas Tax Rate:	0.28

Year	Current Gas Tax Rate	Future Gas Tax Rate	Gallons of Gasoline	Fuel Efficiency Adjusted Gallons of Fuel	Average MPG	Annual MPG Increase	1.0 Scenario Population	Gallons Per Person	Percent Increase in Gallons Per Person	Projected Increase in HCI	Percent Population Increase	Percent Gallons Increase	Federal Portion of HCI Increase
1992	0.20	0.20	8,238,980,000				17,650,479	466.8					
1993	0.20	0.20	8,754,915,000				17,996,764	486.5	4.22%		1.96%	6.26%	
1994	0.20	0.20	8,988,265,000				18,338,319	490.1	0.75%		1.90%	2.67%	
1995	0.20	0.20	9,198,305,000				18,679,706	492.4	0.47%		1.86%	2.34%	
1996	0.20	0.20	9,480,730,000				19,006,240	498.8	1.30%		1.75%	3.07%	
1997	0.20	0.20	9,697,130,000				19,355,427	501.0	0.44%		1.84%	2.28%	
1998	0.20	0.20	10,058,265,000				19,712,389	510.3	1.85%		1.84%	3.72%	
1999	0.20	0.20	10,387,675,000				20,044,141	518.2	1.57%		1.68%	3.28%	
2000	0.20	0.20	10,622,310,000				20,949,316	507.0	-2.16%		4.52%	2.26%	
2001	0.20	0.20	10,761,515,000				21,334,855	504.4	-0.52%		1.84%	1.31%	
2002	0.20	0.20	11,124,805,000				21,723,220	512.1	1.53%		1.82%	3.38%	
2003	0.20	0.20	11,133,245,000				22,103,374	503.7	-1.65%		1.75%	0.08%	
2004	0.20	0.20	11,186,255,000				22,490,022	497.4	-1.25%		1.75%	0.48%	
2005	0.20	0.20	11,239,270,000				23,276,617	482.9	-2.92%		3.50%	0.47%	
2006	0.20	0.20	11,512,362,113		19.8		23,805,220	483.6	0.16%		2.27%	2.43%	

Current Gas Tax Rate:	0.20
Future Gas Tax Rate:	0.28

Year	Current Gas Tax Rate	Future Gas Tax Rate	Gallons of Gasoline	Fuel Efficiency Adjusted Gallons of Fuel	Average MPG	Annual MPG Increase	1.0 Scenario Population	Gallons Per Person	Percent Increase in Gallons Per Person	Projected Increase in HCI	Percent Population Increase	Percent Gallons Increase	Federal Portion of HCI Increase
2007	0.20	0.28	12,323,551,793	12,239,154,135	19.9	0.68%	24,347,034	502.7	3.95%	2.35%	2.28%	7.05%	$ 0.004
2008	0.20	0.29	12,625,745,896	12,539,866,808	20.1	0.68%	24,902,640	503.6	0.17%	2.24%	2.28%	2.45%	$ 0.004
2009	0.20	0.30	12,936,088,165	12,848,692,616	20.2	0.68%	25,473,227	504.4	0.17%	2.25%	2.29%	2.46%	$ 0.004
2010	0.20	0.32	13,254,468,733	13,165,523,132	20.3	0.67%	26,058,593	505.2	0.16%	3.00%	2.30%	2.46%	$ 0.006
2011	0.20	0.33	13,581,080,139	13,490,550,287	20.5	0.67%	26,659,092	506.0	0.16%	3.07%	2.30%	2.46%	$ 0.006
2012	0.20	0.35	13,916,185,631	13,824,036,263	20.6	0.66%	27,275,208	506.8	0.16%	3.03%	2.31%	2.47%	$ 0.006
2013	0.20	0.36	14,259,546,438	14,165,744,555	20.7	0.66%	27,906,502	507.6	0.15%	2.89%	2.31%	2.47%	$ 0.006
2014	0.20	0.38	14,611,199,000	14,515,712,013	20.9	0.65%	28,553,041	508.4	0.15%	2.81%	2.32%	2.47%	$ 0.006
2015	0.20	0.40	14,970,597,242	14,873,396,743	21.0	0.65%	29,213,821	509.1	0.15%	3.20%	2.31%	2.46%	$ 0.007
2016	0.20	0.42	15,337,902,702	15,238,959,789	21.2	0.65%	29,889,139	509.8	0.14%	3.41%	2.31%	2.45%	$ 0.008
2017	0.20	0.45	15,713,053,920	15,612,340,642	21.3	0.64%	30,578,882	510.6	0.14%	3.60%	2.31%	2.45%	$ 0.009
2018	0.20	0.47	16,096,063,949	15,993,552,805	21.4	0.64%	31,283,074	511.3	0.14%	3.73%	2.30%	2.44%	$ 0.009
2019	0.20	0.50	16,487,302,641	16,382,964,312	21.6	0.63%	32,002,395	511.9	0.13%	3.80%	2.30%	2.43%	$ 0.010
2020	0.20	0.53	16,886,682,972	16,780,489,239	21.7	0.63%	32,736,685	512.6	0.13%	3.81%	2.29%	2.42%	$ 0.010
2021	0.20	0.56	17,295,616,362	17,187,530,716	21.8	0.62%	33,488,539	513.2	0.13%	3.82%	2.30%	2.42%	$ 0.011
2022	0.20	0.59	17,714,479,735	17,604,464,005	22.0	0.62%	34,258,650	513.9	0.12%	3.90%	2.30%	2.42%	$ 0.011
2023	0.20	0.63	18,143,480,316	18,031,495,759	22.1	0.62%	35,047,399	514.5	0.12%	3.86%	2.30%	2.42%	$ 0.012
2024	0.20	0.67	18,582,880,809	18,468,887,783	22.2	0.61%	35,855,269	515.1	0.12%	3.85%	2.31%	2.42%	$ 0.012
2025	0.20	0.70	19,032,638,246	18,916,598,097	22.4	0.61%	36,682,181	515.7	0.12%	3.83%	2.31%	2.42%	$ 0.013
2026	0.20	0.74	19,493,063,737	19,374,936,628	22.5	0.61%	37,528,707	516.3	0.11%	3.82%	2.31%	2.42%	$ 0.013
2027	0.20	0.79	19,964,379,738	19,844,125,212	22.6	0.60%	38,395,256	516.8	0.11%	3.83%	2.31%	2.42%	$ 0.014
2028	0.20	0.83	20,446,647,710	20,324,225,668	22.8	0.60%	39,281,941	517.4	0.11%	3.74%	2.31%	2.42%	$ 0.014
2029	0.20	0.87	20,940,218,467	20,815,587,440	22.9	0.60%	40,189,407	517.9	0.11%	3.75%	2.31%	2.41%	$ 0.014
2030	0.20	0.92	21,445,057,201	21,318,176,659	23.1	0.59%	41,117,590	518.5	0.10%	3.70%	2.31%	2.41%	$ 0.015
	TOTAL		396,057,931,541	393,557,011,305									

Current Diesel Tax Rate:	0.20
Future Diesel Tax Rate:	0.20

Year	Historical Diesel Tax Revenues	Current Diesel Tax Rate	Future Diesel Tax Rate	Current Diesel Tax Revenues	Future Diesel Tax Revenues	Current Tax Highway Portion of Diesel Tax Revenue	Current Tax Education Portion of Diesel Tax Revenue	Future Tax Highway Portion of Diesel Tax Revenue	Future Tax Education Portion of Diesel Tax Revenue	Gain for Highways	Gain for Education
1992	303,118	0.20	0.20	303,118,000	303,118,000	227,338,500	75,779,500	227,338,500	75,779,500		
1993	331,707	0.20	0.20	331,707,000	331,707,000	248,780,250	82,926,750	248,780,250	82,926,750		
1994	369,921	0.20	0.20	369,921,000	369,921,000	277,440,750	92,480,250	277,440,750	92,480,250		
1995	393,065	0.20	0.20	393,065,000	393,065,000	294,798,750	98,266,250	294,798,750	98,266,250		
1996	422,225	0.20	0.20	422,225,000	422,225,000	316,668,750	105,556,250	316,668,750	105,556,250		
1997	441,089	0.20	0.20	441,089,000	441,089,000	330,816,750	110,272,250	330,816,750	110,272,250		
1998	491,995	0.20	0.20	491,995,000	491,995,000	368,996,250	122,998,750	368,996,250	122,998,750		
1999	512,804	0.20	0.20	512,804,000	512,804,000	384,603,000	128,201,000	384,603,000	128,201,000		
2000	561,560	0.20	0.20	561,560,000	561,560,000	421,170,000	140,390,000	421,170,000	140,390,000		
2001	611,355	0.20	0.20	611,355,000	611,355,000	458,516,250	152,838,750	458,516,250	152,838,750		
2002	606,788	0.20	0.20	606,788,000	606,788,000	455,091,000	151,697,000	455,091,000	151,697,000		
2003	610,556	0.20	0.20	610,556,000	610,556,000	457,917,000	152,639,000	457,917,000	152,639,000		
2004	675,439	0.20	0.20	675,439,000	675,439,000	506,579,250	168,859,750	506,579,250	168,859,750		
2005	704,322	0.20	0.20	704,322,000	704,322,000	528,241,500	176,080,500	528,241,500	176,080,500		
2006	740,791	0.20	0.20	767,952,038	767,952,038	575,964,029	191,988,010	575,964,029	191,988,010		

Current Diesel Tax Rate:	0.20
Future Diesel Tax Rate:	0.20

Year	Historical Diesel Tax Revenues	Current Diesel Tax Rate	Future Diesel Tax Rate	Current Diesel Tax Revenues	Future Diesel Tax Revenues	Current Tax Highway Portion of Diesel Tax Revenue	Current Tax Education Portion of Diesel Tax Revenue	Future Tax Highway Portion of Diesel Tax Revenue	Future Tax Education Portion of Diesel Tax Revenue	Gain for Highways	Gain for Education
2007		0.20	0.28	781,066,066	1,093,492,492	585,799,549	195,266,516	820,119,369	273,373,123	234,319,820	78,106,607
2008		0.20	0.29	819,750,539	1,190,677,520	614,812,904	204,937,635	893,008,140	297,669,380	278,195,236	92,731,745
2009		0.20	0.30	859,445,993	1,294,980,358	644,584,495	214,861,498	971,235,268	323,745,089	326,650,774	108,883,591
2010		0.20	0.32	900,187,488	1,423,684,054	675,140,616	225,046,872	1,067,763,040	355,921,013	392,622,424	130,874,141
2011		0.20	0.33	941,980,430	1,564,850,882	706,485,323	235,495,108	1,173,638,162	391,212,721	467,152,839	155,717,613
2012		0.20	0.35	984,853,993	1,716,819,378	738,640,495	246,213,498	1,287,614,533	429,204,844	548,974,039	182,991,346
2013		0.20	0.36	1,028,813,414	1,877,335,934	771,610,061	257,203,354	1,408,001,951	469,333,984	636,391,890	212,130,630
2014		0.20	0.38	1,073,844,994	2,048,004,382	805,383,745	268,461,248	1,536,003,287	512,001,096	730,619,541	243,539,847
2015		0.20	0.40	1,119,922,530	2,244,933,627	839,941,898	279,980,633	1,683,700,220	561,233,407	843,758,322	281,252,774
2016		0.20	0.42	1,167,015,619	2,465,949,120	875,261,715	291,753,905	1,849,461,840	616,487,280	974,200,125	324,733,375
2017		0.20	0.45	1,215,133,766	2,713,359,155	911,350,324	303,783,441	2,035,019,366	678,339,789	1,123,669,042	374,556,347
2018		0.20	0.47	1,264,273,642	2,987,741,105	948,205,231	316,068,410	2,240,805,829	746,935,276	1,292,600,598	430,866,866
2019		0.20	0.50	1,314,455,028	3,289,480,951	985,841,271	328,613,757	2,467,110,713	822,370,238	1,481,269,442	493,756,481
2020		0.20	0.53	1,365,703,374	3,618,704,786	1,024,277,531	341,425,844	2,714,028,589	904,676,196	1,689,751,058	563,250,353
2021		0.20	0.56	1,418,078,203	3,977,483,873	1,063,558,652	354,519,551	2,983,112,905	994,370,968	1,919,554,252	639,851,417
2022		0.20	0.59	1,471,711,633	4,372,758,926	1,103,783,725	367,927,908	3,279,569,194	1,093,189,731	2,175,785,469	725,261,823
2023		0.20	0.63	1,526,644,659	4,800,368,094	1,144,983,494	381,661,165	3,600,276,070	1,200,092,023	2,455,292,576	818,430,859
2024		0.20	0.67	1,582,906,746	5,264,860,054	1,187,180,060	395,726,687	3,948,645,041	1,316,215,014	2,761,464,981	920,488,327
2025		0.20	0.70	1,640,519,170	5,768,716,015	1,230,389,378	410,129,793	4,326,537,011	1,442,179,004	3,096,147,633	1,032,049,211
2026		0.20	0.74	1,699,491,796	6,314,489,815	1,274,618,847	424,872,949	4,735,867,361	1,578,622,454	3,461,248,514	1,153,749,505
2027		0.20	0.79	1,759,861,372	6,907,832,356	1,319,896,029	439,965,343	5,180,874,267	1,726,958,089	3,860,978,238	1,286,992,746
2028		0.20	0.83	1,821,650,704	7,542,937,602	1,366,238,028	455,412,676	5,657,203,202	1,885,734,401	4,290,965,174	1,430,321,725
2029		0.20	0.87	1,884,879,336	8,231,410,931	1,413,659,502	471,219,834	6,173,558,198	2,057,852,733	4,759,898,696	1,586,632,899
2030		0.20	0.92	1,949,578,469	8,970,907,836	1,462,183,852	487,394,617	6,728,180,877	2,242,726,959	5,265,997,025	1,755,332,342
	TOTAL			30,810,702,898	90,588,286,752	23,108,027,174	7,702,675,725	67,941,215,064	22,647,071,688	44,833,187,890	14,944,395,963

Current Diesel Tax Rate:	0.20
Future Diesel Tax Rate:	0.20

Year	Current Diesel Tax Rate	Future Diesel Tax Rate	Gallons of Diesel Fuel	Fuel Efficiency Adjusted Gallons of Fuel	Avg. MPG	Annual MPG Increase	1.0 Scenario Population	Gallons Per Person	Percent Increase in Gallons Per Person	Percent Increase in HCI	Percent Population Increase	Percent Reduction from CAFÉ	Percent Increase in Fuel Usage	Federal Portion of HCI Increase
1992	0.20	0.20	1,515,590,000				17,650,479	85.9						
1993	0.20	0.20	1,658,535,000				17,996,764	92.2	7.33%		1.96%		9.43%	
1994	0.20	0.20	1,849,605,000				18,338,319	100.9	9.44%		1.90%		11.52%	
1995	0.20	0.20	1,965,325,000				18,679,706	105.2	4.31%		1.86%		6.26%	
1996	0.20	0.20	2,111,125,000				19,006,240	111.1	5.57%		1.75%		7.42%	
1997	0.20	0.20	2,205,445,000				19,355,427	113.9	2.58%		1.84%		4.47%	
1998	0.20	0.20	2,459,975,000				19,712,389	124.8	9.52%		1.84%		11.54%	
1999	0.20	0.20	2,564,020,000				20,044,141	127.9	2.50%		1.68%		4.23%	
2000	0.20	0.20	2,807,800,000				20,949,316	134.0	4.78%		4.52%		9.51%	
2001	0.20	0.20	3,056,775,000				21,334,855	143.3	6.90%		1.84%		8.87%	
2002	0.20	0.20	3,033,940,000				21,723,220	139.7	-2.52%		1.82%		-0.75%	
2003	0.20	0.20	3,052,780,000				22,103,374	138.1	-1.11%		1.75%		0.62%	
2004	0.20	0.20	3,377,195,000				22,490,022	150.2	8.72%		1.75%		10.63%	
2005	0.20	0.20	3,521,610,000				23,276,617	151.3	0.75%		3.50%		4.28%	
2006	0.20	0.20	3,839,760,192		19.8		23,805,220	161.3	6.61%		2.27%		9.03%	

Current Diesel Tax Rate:	0.20
Future Diesel Tax Rate:	0.20

Year	Current Diesel Tax Rate	Future Diesel Tax Rate	Gallons of Diesel Fuel	Fuel Efficiency Adjusted Gallons of Fuel	Avg. MPG	Annual MPG Increase	1.0 Scenario Population	Gallons Per Person	Percent Increase in Gallons Per Person	Percent Increase in HCI	Percent Population Increase	Percent Reduction from CAFÉ	Percent Increase in Fuel Usage	Federal Portion of HCI Increase
2007	0.20	0.28	3,996,287,028	3,905,330,328	19.9	0.68%	24,347,034	164.1	1.76%	2.35%	2.28%	0.68%	4.08%	$ 0.004
2008	0.20	0.29	4,194,471,688	4,098,752,693	20.1	0.68%	24,902,640	168.4	2.62%	2.24%	2.28%	0.68%	4.96%	$ 0.004
2009	0.20	0.30	4,398,000,071	4,297,229,965	20.2	0.68%	25,473,227	172.7	2.50%	2.25%	2.29%	0.68%	4.85%	$ 0.004
2010	0.20	0.32	4,606,800,123	4,500,937,440	20.3	0.67%	26,058,593	176.8	2.39%	3.00%	2.30%	0.67%	4.75%	$ 0.006
2011	0.20	0.33	4,820,998,116	4,709,902,151	20.5	0.67%	26,659,092	180.8	2.29%	3.07%	2.30%	0.67%	4.65%	$ 0.006
2012	0.20	0.35	5,040,766,694	4,924,269,965	20.6	0.66%	27,275,208	184.8	2.20%	3.03%	2.31%	0.66%	4.56%	$ 0.006
2013	0.20	0.36	5,265,949,263	5,144,067,070	20.7	0.66%	27,906,502	188.7	2.10%	2.89%	2.31%	0.66%	4.47%	$ 0.006
2014	0.20	0.38	5,496,569,725	5,369,224,969	20.9	0.65%	28,553,041	192.5	2.02%	2.81%	2.32%	0.65%	4.38%	$ 0.006
2015	0.20	0.40	5,732,269,951	5,599,612,650	21.0	0.65%	29,213,821	196.2	1.93%	3.20%	2.31%	0.65%	4.29%	$ 0.007
2016	0.20	0.42	5,973,155,881	5,835,078,097	21.2	0.65%	29,889,139	199.8	1.85%	3.41%	2.31%	0.65%	4.20%	$ 0.008
2017	0.20	0.45	6,219,187,209	6,075,668,828	21.3	0.64%	30,578,882	203.4	1.77%	3.60%	2.31%	0.64%	4.12%	$ 0.009
2018	0.20	0.47	6,470,372,496	6,321,368,208	21.4	0.64%	31,283,074	206.8	1.70%	3.73%	2.30%	0.64%	4.04%	$ 0.009
2019	0.20	0.50	6,726,954,297	6,572,275,140	21.6	0.63%	32,002,395	210.2	1.63%	3.80%	2.30%	0.63%	3.97%	$ 0.010
2020	0.20	0.53	6,988,875,540	6,828,516,872	21.7	0.63%	32,736,685	213.5	1.56%	3.81%	2.29%	0.63%	3.89%	$ 0.010
2021	0.20	0.56	7,257,061,861	7,090,391,015	21.8	0.62%	33,488,539	216.7	1.51%	3.82%	2.30%	0.62%	3.84%	$ 0.011
2022	0.20	0.59	7,531,760,455	7,358,558,167	22.0	0.62%	34,258,650	219.8	1.45%	3.90%	2.30%	0.62%	3.79%	$ 0.011
2023	0.20	0.63	7,813,107,223	7,633,223,296	22.1	0.62%	35,047,399	222.9	1.40%	3.86%	2.30%	0.62%	3.74%	$ 0.012
2024	0.20	0.67	8,101,274,452	7,914,533,730	22.2	0.61%	35,855,269	225.9	1.35%	3.85%	2.31%	0.61%	3.69%	$ 0.012
2025	0.20	0.70	8,396,233,963	8,202,595,850	22.4	0.61%	36,682,181	228.9	1.30%	3.83%	2.31%	0.61%	3.64%	$ 0.013
2026	0.20	0.74	8,698,189,787	8,497,458,980	22.5	0.61%	37,528,707	231.8	1.26%	3.82%	2.31%	0.61%	3.60%	$ 0.013
2027	0.20	0.79	9,007,287,815	8,799,306,862	22.6	0.60%	38,395,256	234.6	1.22%	3.83%	2.31%	0.60%	3.55%	$ 0.014
2028	0.20	0.83	9,323,568,355	9,108,253,520	22.8	0.60%	39,281,941	237.3	1.17%	3.74%	2.31%	0.60%	3.51%	$ 0.014
2029	0.20	0.87	9,647,261,477	9,424,396,680	22.9	0.60%	40,189,407	240.0	1.14%	3.75%	2.31%	0.60%	3.47%	$ 0.014
2030	0.20	0.92	9,978,344,353	9,747,892,344	23.1	0.59%	41,117,590	242.7	1.10%	3.70%	2.31%	0.59%	3.43%	$ 0.015
	TOTAL		161,684,747,822	157,958,844,818										

Registration Fee Increase:	0%

Year	Vehicle Registration Fee Revenues	Current Registration Fee Revenues	Future Registration Fee Revenues	Additional Revenue Gain for Highways	Population	Current Registration Fees Per Capita	Future Registration Fees Per Capita
1992	571,710	581,710,000	581,710,000		17,650,479	32.96	32.96
1993	589,532	589,532,000	589,532,000		17,996,764	32.76	32.76
1994	607,420	607,420,000	607,420,000		18,338,319	33.12	33.12
1995	604,985	604,985,000	604,985,000		18,679,706	32.39	32.39
1996	624,245	624,245,000	624,245,000		19,006,240	32.84	32.84
1997	640,458	640,458,000	640,458,000		19,355,427	33.09	33.09
1998	679,040	679,040,000	679,040,000		19,712,389	34.45	34.45
1999	708,830	708,830,000	708,830,000		20,044,141	35.36	35.36
2000	748,826	748,826,000	748,826,000		20,949,316	35.74	35.74
2001	756,781	756,781,000	756,781,000		21,334,855	35.47	35.47
2002	742,047	742,047,000	742,047,000		21,723,220	34.50	34.16
2003	803,329	803,329,000	803,329,000		22,103,374	36.34	36.34
2004	823,673	823,672,496	823,672,496		22,761,145	36.19	36.19
2005	849,231	849,231,191	849,231,191		23,276,617	36.48	36.48
2006		875,440,961	875,440,961		23,805,220	36.78	36.78

Registration Fee Increase:	0%

Year	Vehicle Registration Fee Revenues	Current Registration Fee Revenues	Future Registration Fee Revenues	Additional Revenue Gain for Highways	Population	Current Registration Fees Per Capita	Future Registration Fees Per Capita
2007		902,305,773	902,305,773	0	24,347,034	37.06	37.06
2008		929,854,436	929,854,436	0	24,902,640	37.34	37.34
2009		958,145,902	958,145,902	0	25,473,227	37.61	37.61
2010		987,170,157	987,170,157	0	26,058,593	37.88	37.88
2011		1,016,944,753	1,016,944,753	0	26,659,092	38.15	38.15
2012		1,047,493,688	1,047,493,688	0	27,275,208	38.40	38.40
2013		1,078,795,196	1,078,795,196	0	27,906,502	38.66	38.66
2014		1,110,852,597	1,110,852,597	0	28,553,041	38.90	38.90
2015		1,143,616,111	1,143,616,111	0	29,213,821	39.15	39.15
2016		1,177,100,464	1,177,100,464	0	29,889,139	39.38	39.38
2017		1,211,300,054	1,211,300,054	0	30,578,882	39.61	39.61
2018		1,246,216,069	1,246,216,069	0	31,283,074	39.84	39.84
2019		1,281,882,227	1,281,882,227	0	32,002,395	40.06	40.06
2020		1,318,290,594	1,318,290,594	0	32,736,685	40.27	40.27
2021		1,355,569,839	1,355,569,839	0	33,488,539	40.48	40.48
2022		1,393,754,322	1,393,754,322	0	34,258,650	40.68	40.68
2023		1,432,862,934	1,432,862,934	0	35,047,399	40.88	40.88
2024		1,472,919,625	1,472,919,625	0	35,855,269	41.08	41.08
2025		1,513,920,477	1,513,920,477	0	36,682,181	41.27	41.27
2026		1,555,893,852	1,555,893,852	0	37,528,707	41.46	41.46
2027		1,598,860,029	1,598,860,029	0	38,395,256	41.64	41.64
2028		1,642,824,611	1,642,824,611	0	39,281,941	41.82	41.82
2029		1,687,819,580	1,687,819,580	0	40,189,407	42.00	42.00
2030		1,733,841,761	1,733,841,761	0	41,117,590	42.17	42.17
	TOTAL	30,798,235,052	30,798,235,052	0			