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16. Abstract

This is an interim report giving some preliminary findings on the evaluation of the use of bond financing for State highway investment in Texas. Criteria for evaluating use of bond financing include the following standard criteria for rating alternative revenue sources: (1) equity considerations; (2) economic efficiency; (3) revenue potential and stability; (4) acceptability; (5) administrative feasibility; and (6) applicability. Two additional criteria that are of interest in evaluating bond financing are pay-as-you-go criteria and rate-of-return analysis. Different interpretations of the pay-as-you-go criteria are discussed. Among the factors that may influence the decision about whether to use bond financing is the rate of return that can be gotten from the increased spending made possible by bond issues. A spreadsheet program was used with output from the Highway Performance Monitoring System (HPMS) program output to develop rates of return for different types of projects. Using the latest available (1992) HPMS data set for Texas, simulation runs were made for several levels of funding. The base level of funding was set at a relatively low level, indicated by expected state highway revenues for construction categories covered by the HPMS model and several alternative levels, and were run representing the situation if current spending were supplemented with funds from bond financing. The rate-of-return analysis indicates that the rate-of-return on additional highway investment in Texas is from 16 to 33 percent.

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EVALUATION OF BONDS FOR FINANCING STATE HIGHWAY EXPENDITURES IN TEXAS: PRELIMINARY FINDINGS

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IMPLEMENTATION STATEMENT

This report presents the interim, preliminary findings on the evaluation of bond financing for use in highway finance in Texas. It provides preliminary information that can be used by the Texas Department of Transportation (TxDOT) and others in deciding whether or not to include the issuance of bonds in the mix of funding that is available for highway investment.

Use of bond financing is not, ultimately, a way of financing expenditures. It is merely a way of changing the timing of expenditure and taxation. Eventually, the bonds plus interest and other charges associated with the bond issue must be repaid with revenues either from existing taxes or from new taxes.

This is an interim report that presents preliminary findings, mainly on the rate-of-return analysis, and no specific implementation recommendations are made at this time.

DISCLAIMER

The contents of this report reflect the views of the authors who are responsible for the facts and the accuracy of the data presented herein. The contents do not necessarily reflect the official view or policies of the Texas Department of Transportation (TxDOT) or the Federal Highway Administration (FHWA). This report does not constitute a standard, specification, or regulation.

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TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

SUMMARY

Background information for evaluating bond financing is being evaluated. This involves collecting information on historical background, with emphasis on Texas and other states with respect to highway financing; discussions and criteria comparing bond financing versus pay-as-you-go financing; impacts of bond financing on interest rates, capital markets, ability of a state to maintain desired levels of expenditure over an extended period of time; experience in other states; and other information gathered in the literature. This interim report emphasizes the findings with respect to criteria for evaluating bond financing and the preliminary results of the rate-of-return analysis. The primary purpose of this rate-of-return analysis is to provide a general indication of the rates-of-return from different levels of expenditure, especially increased levels of expenditure that could be funded from issuing bonds.

CRITERIA FOR EVALUATING TAXATION AND BOND FINANCING

Detailed criteria for evaluating different revenue sources are developed from previous research. These criteria are developed into a final listing for use in a logical evaluation of the bond financing alternative for Texas. The following discussion briefly reviews the various options for highway finance with respect to the following criteria for evaluating alternative revenue sources: (1) equity considerations; (2) economic efficiency; (3) revenue potential and stability; (4) acceptability; (5) administrative feasibility; and (6) applicability. Using background information developed in previous research, these criteria are applied to bond financing and to several taxes that are currently used or have been proposed for use in Texas, using background information developed in previous research.

FRAMEWORK FOR EVALUATING BOND FINANCING

Using as a general guide the criteria developed in previous research on criteria for evaluating financing alternatives, a framework was developed specifically for comparing bonds with a pay-as-you-go strategy, which in turn assumes that user taxes are the main source of revenue. This framework explicitly considers alternative scenarios for the overall state fiscal situation, since this is a major factor in current approaches to increases in taxes. That is, the overall situation with respect to the state budget has led to increased attention being paid to bonds as a financing alternative because of the tight state budget. This evaluation will be made regarding the effect of the financing method on present and future highway investment funding availability and the concept of optimum balance between bond financing and pay-as-you-go.

RATES-OF-RETURN AND BOND FINANCING

Among the factors that may influence the decision about whether to use bond financing is the rate-of-return that can be gotten from the increased spending made possible by bond issues. A spreadsheet program was used with output from the Highway Performance Monitoring System (HPMS) program output to develop rates-of-return for different types of projects. Using the latest available (1992) HPMS data set for Texas, simulation runs were made for several levels of funding. The base level of funding was set at a relatively low level, indicated by expected state highway revenues for construction categories covered by the HPMS model and several alternative levels, and were run representing the situation if current spending were supplemented with funds from bond financing.

The rate-of-return analysis suggests several implications for use of bond financing of state highways in Texas. However, these results are considered preliminary and will be further studied in the second year of the project. Projections of funds available for contract construction spending in the period from 1992 through 2002 indicate that about $1.4 billion to $1.6 billion will be available in most years. However, it appears that only about $1.0 billion will be available for the types of expenditures included in the rate-of-return analysis. This indicates that funding will be available for Strategy 3, as discussed in Chapter III. Therefore, additional funding from bond financing would give an incremental rate-of-return similar to that shown for Strategy 4, or over 32 percent per year for amount of funds used in Strategy 4, or about $0.25 billion per year. The incremental rate-of-return decreases to about 16 percent for Strategy 5. This increment is much larger, however, amounting to about $1.0 billion per year in the period 1992-1997.

Although incremental spending from issuing bonds would initially give very large returns, this would also imply less funding in future years, which would mean giving up even higher returns in future years, when the bonds plus interest would have to be repaid. These types of scenarios will be studied further in the second year of the project.

I. INTRODUCTION

Recently, there have been recommendations that bond financing be used in Texas to enable completion of important projects. The use of bonds has been advanced as a means to finance projects during times of economic shortfall and paying for these projects during more prosperous times. There is a need to look at all aspects of bond financing so the department can more fully evaluate this type of financing. Also, a report published in July, 1991 by John Sharp, the Comptroller of Public Accounts for Texas, entitled *Breaking the Mold: A Report From the Texas Performance Review* [45], has numerous recommendations for changing transportation policies in Texas. Although the Sharp report provides some background information on these recommendations, the analysis is incomplete. The objective of this study is to provide a more comprehensive analysis of bond financing for state highways in Texas. This interim report presents preliminary findings of the study.

USE OF BOND FINANCING IN THE UNITED STATES

In general, debt financing has allowed public entities at different levels of government to finance infrastructure projects whenever there was a lack of tax revenues. Governments can finance expenditures by borrowing from the public, issuing and selling bonds, then using the proceeds to cover the deficit.

Historically, it has been primarily the federal government that had recourse to bond financing because of economic or constitutional limits on the use of this funding method by state or by local governments. However, since World War II, local and state governments increasingly resorted to borrowing especially when facing a tax hostile public and the need for major capital improvements. Reliance on bond financing varies among states and jurisdictions. It became an important source of funding for highway construction throughout the century.

The 1920s witnessed the first significant use of bond funding. Forty percent of highway construction was bond funded. In the 1930s, bonds financed the San Francisco Bay Bridge, Pennsylvania Turnpike, and other major projects also. However, with the increase of federal aid to the states, the use of bond financing was reduced and covered only 20 percent of total construction.

Because of the war during the 1940s, highway construction and, consequently, bond financing were limited. But with the expansion of "rebuilding" during the postwar years, the new debt reached $2.2 billion at the state and local levels. In the 1950s the use of bond financing increased dramatically with 30 states and the District of Columbia incurring around $10 billion in new debt. States in the northeast and north central regions, in particular, issued bonds that accounted for almost two-thirds of new obligations used mainly to fund the construction of turnpikes.

In the late 1950s, bonds secured 10 to 15 percent of all state highway receipts. More than 70 percent of highway bonds were issued for the construction of toll roads and around 30 percent for the improvement of free roads.

As mentioned previously, bonding practices varied among the states. During the following two decades, 41 states and the District of Columbia issued around $24.8 billion in highway bonds, 50 percent more than during the previous 60 years. In general, urban eastern states with high population densities used bond financing to provide needed highways, whereas rural western states managed to cover their highway construction needs with state funds and financial aids. Texas was among the states which issued bonds only for financing toll roads. However, in contrast with the late 1950s, toll financing resulted in the issuance of only about one-fifth of all state highway bonds. With the increased availability of federal funds, bond financing for toll roads became less important.

While bond financing of state highways grew during the two decades, toll facility debt stayed relatively constant. State bond issues for local roads increased dramatically in absolute amount, increasing by more than 500 percent.

In the 1980s, federal deficits reached unprecedented levels during peacetime. The policy changes under the Reagan Administration, namely increased defense spending and tax cuts, resulted in the emergence of sharp deficits exacerbated by an unexpected decline in the inflation rate; since taxes were not indexed to inflation until 1985, the tax cut turned out to be much larger than predicted. On the other hand, the recession of 1982-1983 increased the public debt and, consequently, interest costs in the following years.

At the state and local levels, highway bond sales totaled $3.1 billion in 1984 and reached $6.5 billion in 1985. In later years, bond financing gained voters approval increasingly. Public awareness of the importance of a developed infrastructure to the economy allowed state governments to expand their bond practices for funding major projects. States that used bonding for highways in 1990 and 1991 are listed in Table 1.

USE OF BOND FINANCING IN TEXAS

The creation of debt "by or on behalf of the State" is generally prohibited by the Texas constitution, except as specifically authorized within the constitution or as amended by the voters of Texas [Vernon's Ann. Texas Constitution, Art. III, Sec. 49; Sharp Report, p. 27]. Because of this, Texas is regarded as a "pay as you go" state and has not used debt as extensively as many other states, even though Texas state agencies had issued about $7.5 billion of bonds as of December 31, 1990. Bonds are not used for financing highways at the state level in Texas, except for highways constructed by the Texas Turnpike Authority. These bonds typically are revenue bonds and are repaid with toll revenues.

Table 1. Bonds for Highway Improvements

State	FY 90	FY 91	Kind
Alabama	$ 10.5 mil.	$ 13.3 mil.	A
Arizona	360.0	179.8	A
Connecticut	462.0	290.6	*
Delaware	—	120.0	A
District of Columbia	62.8	67.0	B
Florida	—	336.9	A
Georgia	—	125.6	B
		97.5	A**
Hawaii	29.9***	40.0	B
Illinois	108.0	100.0	B
Indiana	48.6	59.4	A
Kentucky	—	300.0	A
Louisiana	28.4	53.5	B
Maryland	260.0	310.0	A
Massachusetts	154.0	191.0	B
Nevada	—	30.0	A
New York	554.0	470.0##	B
Ohio	100.0	100.0	B
Pennsylvania	172.0	84.0	*
Rhode Island	30.5	34.0	B
Tennessee	87.7	—	B
Vermont	—	2.0	B
Washington	—	101.5	B
Wisconsin	54.8	68.9	A
TOTALS	**$2,523.2 mil.**	**$2,838.1**	

A Revenue Bonds

B General Obligation Bonds

* *Connecticut: special tax obligation 20-year variable maturity*

Pennsylvania: (1) federal reimbursement anticipation notes

(2) general obligation

** *First time ever in Georgia that guaranteed revenue bonds are being sold (for the Georgia 400 Tollway Project); expected to be sold this summer*

*** *Does not include refunding bond amount*

State Fiscal Year 1992

Source: TRIP 1991.

Municipalities and counties in Texas have relied heavily upon bond issues. While the state is restricted from using bonds to finance highway investment except for toll roads, Texas local jurisdictions as a whole borrowed more money than local governments in any other state during the 1980s. As can be seen in Table 2, Texas local jurisdictions lead the nation in accumulation of highway associated debt.

This may be due partially to the limited state funds available for local road building, as well as a product of the rapid growth of the 1970s and early 1980s which both resulted in a backlog of road projects and unrealistic expectations that growth would continue indefinitely. One danger is that debt service and maintenance requirements of an expanded local road system may come to tax the resources of some localities in coming years.

Another aspect of bond financing is road utility districts. The combination of a decline in funds, due partially to the oil price rise of 1979-1980 and rapid growth, especially in the five major metropolitan areas, led the Texas legislature to authorize the creation of road utility districts (RUD) in 1984. RUDs encourage private participation in local road development. RUDs may issue bonds up to the value of 25 percent of the assessed value of the real property within the district supported by property taxes on assessing fees. The major advantage of an RUD is that it reduces the burden on a private developer to pay the full costs of roadway improvements. Instead, tax-free bonds are sold and paid for through the special ad valorem tax to spread the costs both over time and among affected users. It is limited by its applicability to only major arterial and feeder roadways. The Texas Department of Transportation Commission has recently approved two RUDs: the Denton County Road District and Northgate Crossing in Harris County.

Table 3 presents a summary of other roadway bond financing mechanisms in Texas: Municipal Utility Districts, Transportation Corporations, Tollways and County Road Districts.

THE TEXAS PERFORMANCE REVIEW

Because of forecasted shortfalls in state revenues and to increase efficiency in state government, the 72nd Legislature of the State of Texas passed Senate Bill 111, which initiated a comprehensive review of Texas state government. "With less than five months to deliver a report to the Legislature, the Comptroller of Public Accounts assembled a team of more that 100 auditors to identify and analyze issues and compile recommendations. The audit teams, in turn, began intensive interviews with agency and legislative staff and other experts, both inside and outside state government." [Vol. 1, p. iii]. The result of these efforts is a two-volume set of recommendations covering almost every aspect of state government spending. [Comptroller of Public Accounts, July 1991].

Table 2. Total Highway-Associated Debt by Selected States: Municipal, County, and State Level, in 1989 ($1000)

State	State Debt	County Debt	Municipal Debt	Total Debt
California	85,140	145,441	550,546	781,127
Florida	1,873,129	313,062	114,838	2,301,027
Illinois	1,750,555	36,763	173,920	1,961,238
Michigan	294,900	37,441	82,524	414,865
Minnesota	112,593	47,161	659,307	819,061
New York	1,732,098	380,475	2,296,033	4,408,606
Ohio	271,938	23,232	294,519	589,689
Pennsylvania	2,750,904	44,995	79,379	2,875,278
Virginia	605,182	180,410	458,938	1,244,530
Texas	567,225	1,992,586	2,597,203	5,157,014
National	28,066,297	5,621,423	11,608,430	45,296,150

Source: **Highway Statistics, 1990.**

Table 3. Innovative Roadway Financing Mechanisms in Texas

Name	Authorizing Body	General Purpose	Geographic Area	Confirmation Election Required	Funding Mechanism	Initiated by	Examples
Road Utility District (RUD)	State Highway and Public Transportation Commission	Construct, acquire, improve arterial or main feeders only	County, city or part or combination; not required to be contiguous	Yes	Bonds (2/3 voters approval) $0.25 per $100 assessed value for maintenance bonds 20 to 25 % of land values	All landowners	Denton county Proposed in Dallas, Austin, and Houston
Municipal Utility District (MUD)	Texas Water Commission; may petition Transportation Commission to acquire RUD powers	Preservation of all natural resources	County, city or part of combination; not required to be contiguous	Yes	Bonds (majority voter approval)	Majority in-value landholders or by 50 persons	Bastrop County
Transportation Corporation	Texas Transportation Commission	Promote, develop public transportation facilities and systems; secure and obtain rights-of-way; assist in planning and design; assist financing state highways	All or part or combination of political subdivision of the state	No	Bonds or donation	Three or more qualified electors in area	Grand Parkway (Houston) and Galveston-Alvin-Pearland
Tollways	Texas Turnpike Authority, city, county, political subdivision, or private	Develop, operate, maintain transportation facilities	City, county or political subdivision or private land	No (yes if bonds issued)	Bonds or user fees	City, county, political subdivision, private landowners	Dallas North Tollway; Mountain Creek Lake Bridge; Houston Ship Channel Bridge; Ham's County Toll Authority; Galveston County Toll Bridge; and Rio Grande River Toll Bridges at El Paso, Laredo, Del Rio, Eagle Pass, Roma, Hidalgo, Progresso, and Brownsville
County Road District	County Commissioners Court of County	Construct acquire, maintain, operate roads and turnpikes; privately constructed turnpikes; privately constructed roads purchased	All or part of county or contiguous counties	No	Bonds up to 25% of land value; bonds (2/3 voter approval); road tax based on property value (majority voter approval up to $0.15 per $100 assessed value tax)	Commissioners Court; 50 voters in district petition road tax election	Southwest Travis County and Williamson County

Source: Transportation Research Board

Capital Finance and Debt Management

One of the areas that was extensively evaluated in the Performance Review was capital finance and debt management [Vol. 1, Chapter 7]. The Review notes that the State of Texas has the lowest state debt burden and the highest local debt burden among the largest ten states. Although the state debt burden is low, it has been growing, and the Review sees an increased role for debt management in the future. The performance review states that different types of bonds put varying amounts of pressure on state finances, with the two most significant types of bonds being general obligation bonds and bonds that are payable from the state's General Revenue Fund, some of which are general obligation and some of which are not. Although many general obligation bonds are designed to be paid from revenue sources other than the General Revenue Fund, "... a constitutional draw is made from state revenues to pay the debt service" [Comptroller of Public Accounts, Vol. 1, p. 84]. The two principal types of bonds that fall into these categories are general obligation bonds issued to finance loan programs and to finance capital expenditures. The general obligation bonds used to finance loan programs will not be a drain on general revenues unless there is extensive default in these loan programs. The bonds used to finance capital expenditures are quite different, and all of the debt service for these comes from the General Revenue Fund.

As of March 31, 1991, the amount of general obligation and general revenue-backed bonds had grown to $3.1 billion from a level of $2.4 billion at the end of fiscal year 1986. The bonds for state capital investment had grown to $1.4 billion, an increase of 45 percent over 1986. This increase in bonds outstanding for capital expenditures is mainly related to funding for prison construction and for the Superconducting Super Collider [Comptroller of Public Accounts, Vol. 1, p. 85].

The Performance Review noted the increasing needs for infrastructure investment and that the state "... should begin to plan now so that the required capital expenditures can be made without threatening Texas' financial strength." To accomplish this goal, the Performance Review recommended that the state "... through the Bond Review Board, develop and the Legislature adopt a broad set of debt indicators to help establish state debt limits" [p. 86]. The Performance Review made several recommendations for better managing capital expenditures and debt.

Transportation Recommendations

The Texas Performance Review made numerous specific recommendations for improving efficiency in the State's transportation agencies and functions, including consolidating functions, reducing the number of highway districts, and changing various fees and tolls. A separate section of the Volume 2 report [Comptroller of Public Accounts, July, 1991, Vol. 2, Part 1, "Transportation Issues"] includes these recommendations. The Performance Review noted that the funding levels for state transportation expenditures were

sufficient for funding only about 38 percent of all authorized highway projects planned for the next ten years. Because of this lack of funding, the Performance Review recommended that TxDOT [Vol. 1, p. 93]:

> ... be statutorily authorized to use limited obligation bonds of up to 15 percent of construction spending not to exceed $150 million per year, and $750 million in the aggregate at any one time. The debt service on these bonds would be payable by a priority dedication of the motor fuels tax revenues as deposited in the State Highway Fund. The bonds would be issued by the Bond Review Board. If additional federal highway construction funds are made available to Texas (which is presently being considered in Congress), the revenue from the sale of highway bonds could be used to match Texas' share of these federal funds.

CONTENTS OF REPORT

Chapter II of this report summarizes information on criteria for evaluating alternative taxes for financing state highways in Texas. This review summarizes both general criteria and specific criteria for evaluating the use of bond financing. Chapter III gives the results of the rate-of-return analysis.

II. CRITERIA FOR EVALUATING TAXATION AND BOND FINANCING

GENERAL EVALUATION CRITERIA

General principles for evaluating taxation alternatives are discussed in a previous report [Isser, Ballouz, and McFarland] prepared on Texas highway finance that can be used as a guide to determining an optimal package of highway revenue instruments. The most basic general principles are progressiveness (or its mirror image, regressiveness) and two types of equity, horizontal and vertical. Progressiveness indicates the extent to which people with higher incomes pay a greater or smaller percent of their income for a tax. If persons or families with higher incomes pay a smaller percent of their income for a tax, then the tax is regressive. Sales taxes usually are regressive, and income taxes are usually progressive.

Horizontal equity requires treating vehicles in the same vehicle class equally, while vertical equity requires assigning revenues to classes of vehicles according to their cost responsibilities. The key here is to base fees on cost responsibilities of vehicles and to avoid exemptions, whether as an attempt to subsidize agriculture interests or independent truckers, provide benefits to deserving individuals, or shift the tax burden from rural to urban districts. If the legislature feels that some specific group is worthy of a subsidy or lesser tax burden, it should vote directly upon the issue and not impose complicated requirements upon the highway tax system. In the same way, excepting constitutional requirements, the allocation of funds should be made as simple as possible. Overall evaluation criteria were divided into two categories: basic and practical, with three criteria in each group, as discussed below.

Basic Evaluation Criteria

Basic evaluation criteria include equity, efficiency, and revenue potential. Equity, as mentioned previously, covers the ideas of horizontal equity and vertical equity. Horizontal equity refers to assessing fees proportionately to cost responsibilities and benefits, while vertical equity studies how the impacts of a revenue source are distributed among income groups.

Efficiency refers to the extent to which the tax affects the economy and meets the objective of maximizing social benefits with relation to costs.

Revenue potential involves the amount, the stability over time, and the evasion potential of revenues raised by the tax.

Practical Evaluation Criteria

Practical evaluation considerations include acceptability, administrative feasibility, and applicability. Acceptability refers to whether the tax is acceptable to the general public, various political interests, and special interest groups.

Administrative feasibility is a criterion that evaluates administrative costs, including collection, processing, enforcement, and evasion costs; and compliance burden costs, including record keeping, preparation, and submission costs.

The applicability criterion refers to the appropriateness of a revenue source in a defined context, regardless of administrative costs.

In previous research, these basic and practical criteria were applied to several taxes that are currently used or have been proposed for use in Texas. Tables 4-8 summarize the application of these criteria to these financing methods. Criteria are broken down into two major groups, the first relating to basic conditions to be met by the tax and the second including practical considerations for application.

BOND, OR DEBT, FINANCING

Using bonds, or debt, to finance highways is a rational economic mechanism of spreading the cost over the future beneficiaries of the investment. Assuming that the decision to invest is made prudently, taking into account the net benefits of the project and applying conservative estimates of future highway demand, bond financing can be a valuable addition to the highway finance tool kit. However, there are problems with debt, such as the tendency by localities to incur debt to build roads for hypothetical development, leaving future generations with a crushing burden if this development fails to emerge, or the use of bonds as a means of avoiding difficult fiscal decisions. It is generally agreed that debt should never be used to finance current expenses such as maintenance.

Therefore, in exploring the wide range of bond financing mechanisms, it is necessary to consider the benefits and problems of different options in order to apply the type of bonds that are most suitable to the project they are issued for and most appropriate in the prevailing economic and financial conditions. Evaluating the different types of bonds may be approached from the standpoint of the issuer-seller or the investor-buyer. It is important for both to consider mutual concerns for the success of the transaction. The buyer's demand for bonds is related to his wealth, the expected return on the bond relative to the expected return on alternative assets, degree of uncertainty or risk associated with the return on the bond relative to another asset, and the liquidity of the bonds.

In Texas, there seems to be a tendency for local jurisdictions to take on debt at very high levels, at least in comparison to other states. This may be due partially to the limited

Table 4. Summary of Evaluation Criteria for User Fees.

CRITERIA						
	Basic Evaluation			Practical Considerations		
USER FEES	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
Motor Fuel Taxes	• Well met; cost responsibilities assessed to users. •For passenger vehicles, amount spent on fuel is relatively constant as percent of total expenditures at different income levels.	•Relatively efficient because users pay the tax. • In the long run, higher transportation costs as a result of higher taxes; may affect consumer goods prices, capital investments, labor employment, and productivity, but productivity gains probably more than offset the cost.	• The most important source of revenue. • Disadvantage: not sensitive to inflation under a static form. •Under a variable form, revenues fluctuate with prices (but when prices fall, revenues are lower) • Floors and ceilings prevent sharp fluctuations.	• Closely related to benefits received from highways and, therefore, well accepted.	• Easy to administer, in general, and low cost. • Under a variable form, more complex requiring periodic review and enforcement programs. • Administrative costs are high and legal feasibility expensive when applied at the local level.	• Limited at the local level. •The more the local motor fuel tax structure differs from the state tax, the higher administrative costs are. • Collection costs are lower when undertaken at the state level.
Vehicle Registration Fees	• Attempts to compensate for cost responsibilities of heavy trucks through higher fees raise equity issues: distance is not taken into account; vehicle registration fees do not replace weight distance taxes. • Less regressive and more effective when computed as a function of the vehicle's age and value.	•Do not promote efficiency as well as weight-distance or weight-damage taxes.	• Second major source of revenue • Taxes levied as a percentage of the estimated market value are sensitive to inflation.	•Generally accepted. • Because of its high public visibility, revisions may be subject to wide objections.	• Expensive: costs estimated at 13% of receipts.	• Either flat rate or graduated according to weight or horsepower. • Computed as a function of the vehicle's age and value in few states.

Table 4. Summary of Evaluation Criteria for User Fees. (Continued)

User Fees	Equity	Efficiency	Revenue Potential	Acceptability	Administrative Feasibility	Applicability
Third Structure Taxes	•Can promote cost responsibilities that are proportional to the damage caused on highways by vehicles according to their weight, configuration, and mileage traveled.	• Weight and distance traveled constitute an acceptable compromise for a more efficient tax given the difficulty of measuring all other variables that affect cost responsibilities (i.e., type of roads, climatic conditions...). • Could affect interstate commerce by diverting traffic to rail and/or by increasing shipping rates.	• Productive source subject to business economic cycles.	• Opposed by owner/operator truckers: trucks are already fairly taxed; the trucking industry has narrow profit margin already.	• Administrative cost evaluations as a percentage of revenues range from 2 to 11%. • Carriers already keep records on distance traveled and, therefore, compliance costs are low. • Under a uniform state administered form, costs of auditing records and enforcing the tax are lower. • Evasion can be avoided with a "proof of payment" program.	• Because of legal and institutional issues, uniformity is better.

Table 4. Summary of Evaluation Criteria for User Fees. (Continued)

USER FEES	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
Tolls	• Most precise form of "pay-as-you-go" financing. •Disadvantage: perceived as double taxation since users are already paying motor fuel taxes. • Negative impact on development in the areas near toll roads (less frequent access).	• Expedite construction completion. • Funds flow directly from the user to the provider and are available at the beginning of a project. • Must cover operating and maintenance costs plus debt expenses. • More efficient when function of time of the day and nature of the vehicle. • Capital costs during inflation are lower because of quicker implementation. • Disadvantage: externalities when vehicles stop to pay (i.e., time delay, air quality, fuel consumption, plus interest costs).	• Continuous source of revenue to cover maintenance and operating costs. • Depend on demand level, traffic mix and changes in travel behavior. • Demand is affected by the level of improvement on "free" highways. • Do not respond promptly to inflation because rate changes are complex from the political standpoint and increases reduce the number of users.	• Public support is necessary: a toll road must provide advantages as compared to a free facility to win acceptance.	• Collection costs are high (estimated at 18% of revenue). • Administered and operated by state authorities. • Do not have to comply with Federal regulations.	• Most useful in urban areas where demand level is high enough. • Insulated from political influence because usually governed by an independent board of directors. • Financed by general obligation bonds, revenue bonds, private financing, or combinations of these.

Table 4. Summary of Evaluation Criteria for User Fees. (Continued)

User Fees	Equity	Efficiency	Revenue Potential	Acceptability	Administrative Feasibility	Applicability
Tire Excise Tax	• Good tax for increasing vertical equity between cars and trucks. • Equitable since associated to the most important cost responsibility factors, weight and mileage •Retread and new tires cause same damage; when the tax is applied only on new tires, equity is reduced	• Varies with weight and mileage; well related to cost responsibility. • Little or no effect on interstate commerce: carriers prefer to buy new tires and avoid problems and delays.	• Function of the level of demand for tires. • High possibility of evasion when applied at the state level: tires can be purchased in non-taxing states.	•Generally acceptable. •Similar to general sales tax.	• Low costs	• Better when applied at the federal level.

Table 5. Summary of Evaluation Criteria for Non-User Fees.

CRITERIA						
	Basic Evaluation			Practical Considerations		
NON-USER FEES	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
Sales Tax	• Sales of vehicles and parts are fairly well related to transportation use.	• Does not discourage economic development. • Objections: may lead to public overspending because the taxes are hidden in the prices of the goods. • Might be regressive.	• High revenue potential. •Potential source of transportation revenue if sales on transportation items are dedicated.	• The most acceptable form of general taxation. • Accepted by economists and businessmen: does not fall on investment.	• Relatively easy to administer.	• Applied at state, local, and federal levels. • Legal impediments at the state level involving imported goods and mail sales.
Property Taxes and Fees	• Rates are not uniform; fairness problem.	• Burden distributed roughly in proportion to income. • Because of exclusions, wealth is not really the base of the tax.	• Important source at the local level. • Predictable revenues because the rate is set after the value of the base is known.	• Limited to voters. • High to state officials because the alternative would be an increase in state taxes and aids.	• Hard to evade. • Slow structure changes.	• Mainstay of local finance. • Not earmarked.
Severance Taxes	• Resource owners bear the burden. • Consuming states perceive the tax as being an unfair exploitation by producing states.	• Severance taxes replace property taxes: shift the burden to the act of severing and eliminate the resource from the property tax base. • The high cost of severing is the decrease in wealth.	• Largest yield in oil and gas taxes. • Not significant except in a few oil producing states. • Fluctuates with oil and gas prices.	• Viewed as a barrier to production when price levels do not allow profits.	• Costly because of the variety of taxed resources and the difficulty to distinguish between profitable production and marginal production; rates are not uniform.	• Designing a tax such as to maximize revenues without discouraging production is difficult.

Table 5. Summary of Evaluation Criteria for Non-User Fees. (Continued)

NON-USER FEES	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
Income Taxes	• Ability to pay has no relationship with benefits; equity problem.	• Distortions exist from exemptions and exclusions.	• Major revenue source for federal and state governments. • Indirect access to revenues for highways through general funds.	• Widely accepted because it is based on the ability to pay. • Difficulty of defining taxable income.	• Possible evasion because of exemption rules. • The tax is "in place" but reforms are continuously proposed.	• The major problem for application is the difficulty of defining taxable income.
Gambling Taxes	• Fair because payment is voluntary.	• Distributional issue; low income people tend to spend more on lotteries than high income people.	• Not likely source for transportation revenue.	• Relatively popular (especially lotteries). • The idea of gambling always faces objections.	• Varies among states and different regulations for different measures.	• Possible legal impediments at the interstate level and use of the mail.

Table 6. Summary of Evaluation Criteria for Special Benefit Fees.

CRITERIA						
	Basic Evaluation			**Practical Considerations**		
SPECIAL BENEFIT FEES	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
Impact Fees	• Apportionment of the fees among new users or all users raise equity considerations.	• May raise costs of development.	• Function of the quantity of new development. • Fluctuates with the level of new construction; hard to predict. • Responsive to inflation and growth.	• Frequent litigation. • Not inherent to the fees but rather to the opposition to tax increases.	• Complicated. • Placed in special trust funds.	• Applied by local government. • Effective in high growth areas. • Legality varies among states. •Three general rules where applicable: 1) New development has to require facilities expansion, 2) Fees must not exceed costs, 3) Revenues spent only on the required expansion.
Special Assessments	• Same as for impact fees.	• Costs of improvements paid by the benefiting area with no need for tax increase.	• Limited to the willingness to apply assessments and the requirement that the property value increases by the assessment amount. • When costs rise, action should be taken by the jurisdictions to increase assessments.	• Opposed by payers.	• Less complex than impact fees but more complicated than general taxation (requires special tax rolls and the receipts are placed in special funds.)	• Applied by special districts. • Applied in areas where improvements increase property values. • States give authority to local government to impose special assessment.
Tax Increment Financing	• Since created to improve depressed areas and, therefore, imposed on disadvantaged people, the tax is seen as "unfair."	• Raises money for infrastructure development without tax increase.	• Small yield. • Uncertain flow of funds.	• Risk on bond holders is high; accepted when risk is compensated by higher returns.	• Many restrictions placed on its use.	• Evolved in urban areas. • Marketing tax increment bonds are difficult.

Table 7. Summary of Evaluation Criteria for Private Financing.

	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
PRIVATE FINANCING	• The allocation of highway development costs between the private and public sectors creates equity problems. • Negotiated agreements provide advantages in this respect as compared to the mandatory fee approach. • Voluntary contributions result in inequity among low growth and high growth areas.	• Private participation introduces competition, leading to lower operational costs.	• Unpredictable, hard to integrate in long term transportation planning. • Promotional policies are not enough to generate a stable funding base. • Leasing/selling arrangements generate a more steady and dependable cash flow. • Donations are tied to a single project; unpredictable.	• Negotiated agreements are well accepted when property rights are preserved. • Joint responsibility is attractive to developers seeking long term competitive advantages. • State governments may perceive private contributions as a disadvantage: private funds cannot be used as a state's matching share on federal-aid highway projects and thus contributions reduce reimbursements of proportional costs paid by the federal government.	• Complex because of state and federal regulations. • Projects receiving federal support are subject to costly and time consuming procedures. • Small government entities need state agencies' technical and administrative assistance.	• Most common and most successful in areas where the private sector has a strong interest in development. • When regulations are too restrictive, developers may choose to locate elsewhere. • Since private and public funds are combined, liability issues (i.e., designating legal responsibility) may arise.

Table 8. Summary of Evaluation Criteria for Debt Financing.

	EQUITY	EFFICIENCY	REVENUE POTENTIAL	ACCEPTABILITY	ADMINISTRATIVE FEASIBILITY	APPLICABILITY
DEBT FINANCING	• With revenue bonds, project users bear the full cost of financing.	•Speed up construction and payment on highway projects.	•Balancing debt financing with other revenue sources is necessary. •Important source, but over-borrowing may lead to a lack in revenues for current maintenance and construction spending.	•Revenue bonds are popular because less risky and does not require voter approval. • Negotiated bonds are attractive for their flexibility to variations in interest rates. • Citizens are skeptical of debt financing: high interest payments perceived as evidence that they are paying more than the value of projects. •The political appeal of specific large new projects helps to overcome legislative problems.	•Financial expertise is needed for the management of new debt instruments. • State or local regulation requirements may be costly.	•Depends on the state financial position and level of indebtedness. • Most appropriate for catching up on large capital needs. • More appropriate in high growth areas able to meet debt requirements.

state funds available for local road building, as well as a product of the rapid growth of the 1970s and early 1980s, which both resulted in a backlog of road projects and unrealistic expectations that growth would continue indefinitely. One danger is that debt service and the maintenance requirements of an expanded local road system may come to tax the resources of some localities in coming years.

Bond Financing Versus Tax Increase

How should the government finance expenditures? Should taxes or debt be the solution, or how can this finance be divided? In the 19th century, economists advocated balanced budgets as a matter of equity on the benefit principle according to which users must pay for expenditures they are benefiting from. Some economists also believed that balanced budgets force governments to study the benefits and costs of public spending more carefully. For the government entity issuing the bonds, criteria used for the evaluation of different options may be divided into two major categories, as discussed previously:

1. Basic evaluation criteria including equity, efficiency, and revenue potential.
2. Practical considerations including acceptability, administrative feasibility, and applicability.

More recently, the focus of writers on fiscal theory is on the economic efficiency of taxation and debt finance. A different view advocates borrowing as a means of funding a temporary increase in government spending, with only enough increase in taxes to finance the interest payments on the debt. This line of reasoning relies on the observation that the excess burden of taxes is a function of the square of the tax rate. Therefore, it is better to have many small increases in tax rates over time to finance interests, than a single large increase to finance spending.

Some economists argue that the previous analysis ignores that debt financing by itself involves additional excess burden which outweighs the advantage of avoiding a large single tax increase. In his paper, "Debt and Taxes in the Theory of Public Finance" (1985), Feldstein developed a model comparing the burden of debt financing to the burden of a tax increase. He concluded that a tax increase is preferable, and showed that a permanent increase in government spending cannot be financed by a permanent increase in government debt. However, if the increase in spending is temporary, the choice between a tax increase and debt financing depends on other factors like the capital stock level.

In an opposing view, Barro (1979) suggested that the burden of tax financing is equal to the burden of debt financing: taxpayers are aware that deficits are delayed taxation. Private saving will increase such as to offset public borrowing completely.

The common argument is that bond financing has several disadvantages, such as:

* It shifts the burden of expenditures to future generations. This violates the benefit theory of taxation according to which those who benefit from government spending should bear the costs.

* Costs of bond financing are high and include a reduction in future output resulting from reduced private investment in addition to the welfare costs of higher taxes that will be imposed later for interest payments.

* It might lead to inflation. This idea will be discussed under the section on the impacts of bond financing.

* It might lead politicians to increase spending unnecessarily since this funding mechanism is a form of "hidden taxation" which might be better accepted by the public.

Eliminating the deficit by raising taxes can be strongly opposed by the public. How much can tax rates be increased before starting to lead to reduced revenues (the Laffer curve)? Choosing between bond or tax financing to reduce deficits is not an easy task.

Incidence of Deficit Financing

The incidence of deficit financing is still a controversial issue. Who bears the burden when the government sells bonds to finance expenditures? There have been two opposing views on this subject. From the 1930s until the late 1950s, the idea that prevailed among economists was that the burden of deficit financing is placed on the economy at the time borrowing takes place. Public expenditures shift resources from the private sector, reducing the output of private goods and services. Hence, present generations bear the burden of bond financing. However, since a tax increase, if necessary, will fall on those who also receive the proceeds when the debt has to be repaid, there is not a net burden on society. Debt repayment is only a transfer among people at that time.

Buchanan (1958), in his *Public Principals of Public Debt*, argued that deficit financing imposes a net burden on future generations and that bondholders do not gain when debt is retired because they are simply exchanging assets (money against bonds). Furthermore, interest on government bonds cannot be considered as a gain either because bondholders could have purchased private assets and received the same returns. Taxpayers, on the other hand, bear a burden in paying higher taxes to finance both interest payments and the debt repayment.

One argument that could reconcile the two views is that taxpayers, knowing that debt financing will induce higher taxes in the future, feel the burden in the present; payments, however, are actually made in the future. This implies that citizens are well informed about government spending and tax policies and know exactly what bond financing means in the

future, which is not very plausible.

Impact of Bond Financing

Bond financing affects several economic factors, such as investments, savings, and interest rates. Economists have analyzed these effects in the investment-saving framework. When the government is considered as a competitor among other borrowers, it is likely to bid away funds from the private sector. Savings that would have been channeled into private investment fall, private investment falls consequently, and interest rates increase. The amount by which private investment falls depends on the elasticities of saving and investment. The more inelastic the saving curve, the more investment will fall.

This analysis has been criticized by some economists who argue that taxpayers are aware that government borrowing will induce higher taxes in the future. They will save more, shifting the saving curve back to the right. The net outcome of the shift can be such that private investment will not be affected. However, it seems quite unrealistic that taxpayers have perfect foresight of government policies.

If borrowing leads to a reduction in investment, then the nation's capital stock growth slows down because people end up owning bonds instead of real capital with higher productivity. Aggregate output will be lower in the future. The magnitude of this reduction in output depends on the productivity of private investment.

It is important at this point not to ignore tax considerations: the government must compete with private investments net returns and, therefore, can divert resources from the private sector paying interest rates on bonds well below private projects real returns.

Another debatable concern with debt financing is inflation. Bond financing has no direct effect on the monetary base and, therefore, on the money supply. Consequently, it will have no obvious inflationary consequences. However, bond financing might put upward pressure on interest rates; if the Federal Reserve goal is to prevent high interest rates, they will purchase bonds causing their prices to go up. Bond purchases result in an increase in money supply. When the deficit persists, the quantity of bonds supplied keeps on growing, the Fed buy again, and the money supply keeps increasing, resulting in inflation. Much research on the importance of budget deficits to the inflation process is being currently done, and economists are concerned that large deficits may lead to inflation.

III. RATE-OF-RETURN ANALYSIS

One of the objectives of this study is to obtain rates-of-return for highway investment in Texas using the 1992 Highway Performance Monitoring System (HPMS) sample data. The estimation procedures very closely follow a previous study, TxDOT Project 1221, entitled *An Assessment of Transportation Infrastructure Needs* [1]. To develop estimates of user cost savings and internal rates-of-return for highway investment in Texas, researchers studied a range of investment scenarios using Texas HPMS data from the 1992 Texas HPMS sample data. Originally, researchers had hoped to be able to obtain some rates-of-return for highway investment at the district level; however, because of lack of sufficient HPMS sections in some of the districts, there was not enough meaningful data for analyses. Therefore, a rural versus urban area type of investigation is developed to partially serve this role of the study.

USER COST CALCULATIONS

From the Impact Analysis and Need Analysis in HPMS, average travel speed, operating costs, and accident rates (for fatal, injury, and property damage) per 1600 vehicle kilometers traveled (1000 vehicle miles traveled) are given in the output for the last year of each analysis period. Using accident rate factors, the three accident rates are first converted into number of fatalities, number of nonfatal injuries, and number of damaged vehicles. By multiplying unit accident costs to the respective accident numbers, accident costs by accident type per 1,600 vehicle kilometers traveled are obtained, and the summation of the three types of accident costs yields the total accident costs per 1,600 vehicle kilometers traveled. Amounts of travel time for traveling 1,600 vehicle kilometers traveled for each of the seven vehicle types is calculated by dividing vehicle kilometers traveled by the average travel speed. By applying the vehicle mix, also an output item, and the respective unit travel time costs by vehicle type to the travel times, time costs per 1,600 vehicle kilometers traveled are obtained. This gives the three described user costs: operating costs, accident costs, and time costs, in dollars per 1,600 vehicle kilometers traveled. Multiplying daily vehicle kilometers traveled, another HPMS output item, to the user costs per 1,600 vehicle kilometers traveled gives the daily user costs of the three categories, which are further multiplied by 365 days to yield the annual user costs of each category. The summation of the three annual user costs categories yields the total user costs. Since defaults used in the development of user cost relationships in the 1987 version of the HPMS Program are based on 1980 data, updating factors developed in the recent National Cooperative Highway Research Program (NCHRP) Project 7-12 [2], MicroBENCOST, and some national indexes are used to bring all costs to 1992 dollars. A brief discussion on updating each of the user costs categories is presented below.

Operating Costs

Defaults used for determining relationships between highway characteristics and the resulting vehicle operating costs output from the 1987 HPMS Impact Model were based on 1980 data. Therefore, the unit operating costs output from the Impact Analysis of HPMS are updated from 1980 to 1992 using the Gross National Product implicit price deflator, using an update factor of 1.7.

Time Costs

Unit time costs for the seven vehicle types used in HPMS were taken from NCHRP Study 7-12 [2], and were updated to 1992 dollars using the Consumer Price Index (CPI). The following list contains the 1992 updated unit time costs:

	- $ -
Small Passenger Cars	10.46
Large Passenger Cars	10.46
Pickup/Van	10.46
Single Unit Truck, 2-Axle	14.64
Single Unit Truck, 3+-Axle	17.47
Multi Unit Truck, 4-Axle	21.78
Multi Unit Truck, 5+-Axle	24.17

Accident Costs

Conversion factors to change fatal, nonfatal injury, and PDO (Property Damage Only) accident rates into numbers of fatalities, non-fatal injuries, and damaged vehicles were taken from *The Economic Cost to Society of Motor Vehicle Accidents* by the National Highway Traffic Safety Administration (NHTSA) [16] published in 1983, but based on 1980 data. These factors are calibrated in a previous study [1]. The current study used these same calibrated factors for the three accident types; they are shown below.

Fatalities per Fatal Accident	1.128
Nonfatal Injuries per Fatal Accident	1.081
Injuries per Injury Accident	2.209
Damaged Vehicles per PDO	1.700

Unit accident costs adopted were from NCHRP Study 7-12 [2] and are updated from 1990 to 1992 dollars using the CPI. They are as follows.

	Rural	Urban
	- $ -	- $ -
Per Fatality	1,192,103	1,049,394
Per Nonfatal Injury	26,718	15,344
Per Damaged Vehicle	2,296	1,363

It is noted that the cost per fatality represents only the economic cost and not the full loss from accident fatalities.

DATA ITEMS

In the HPMS Investment and Impact Analyses, there are several data items which are essential in running these analyses. These include traffic growth rate, initial funding allocation, and the analysis periods.

Traffic Growth Rates

From the 1992 HPMS sample data, an average traffic growth rate of 2.29 percent is calculated. This growth rate is used for forecasting the funding levels for the 10 year period, 1992-2002.

Initial Budget Levels

Researchers studied six funding strategies. The initial budget levels are set as follows to allow for variations in the funding levels. Strategy 1 starts in year 1 at an annual budget of $0.5 billion dollars; Strategy 2, $0.75 billion; Strategy 3, $1.0 billion; while Strategy 4 has an initial budget of $1.25 billion. These four funding levels are assumed to grow at 2.29 percent, the average traffic growth rate described above. The projected funding amounts in 1997 and 2002 are then distributed across the functional classes by area type. The distribution percentages are based on the funding distribution obtained using the constrained full needs with no lane restriction on the 1992 Texas HPMS data. Strategies 5 and 6 represent the unconstrained full needs strategies with the former having a 12-lane restriction while the latter has a 16-lane restriction.

Analysis Period

The analysis period used in running the HPMS analyses is 20 years, covering the period from 1992 to 2012; however, funds are allocated only to the first 10 years, that is, the first and second periods of the analysis, with third and fourth periods each receiving no

funding at all. As stated above, in an attempt to capture a more realistic situation, user benefits at the end of the analysis period are assumed to grow for five additional years at the same rate as the traffic growth rate. Therefore, the internal rates-of-return obtained for the study are based on a total of 25 years.

INVESTMENT ANALYSIS OUTPUT

From the HPMS Investment Analysis, actual funding levels used to produce the user cost data items are output in the Investment Summary, and the user costs items such as accident numbers, vehicle-miles traveled, vehicle mix, average speeds, and operating costs are output from the Impact Analysis.

Actual Funding Levels

The six funding strategies used in this study have the following total investment levels. Strategy 5 represents constrained full needs with the number of lanes restricted to 12 at the maximum, while Strategy 6 is restricted to 16 lanes. Each funding level is assumed to grow over the 10 years -- that is, the first and second periods covering the duration of 1992-2002 -- at 2.3 percent annually, the traffic growth rates discussed above. The cumulative funding levels for the six strategies are given in Table 9. The funding allocation by rural/urban and by functional class used in the analyses for the first and second periods is shown in Table 10. From the first four strategies in Table 9, it is apparent that funding for the rural area represents about one-third of the total funding invested while urban projects capture the remaining two-thirds. However, as funding is increased beyond that of Strategy 4, these ratios change. The additional amount of funding would be spent on urban projects, indicating funding of $5.2 billion to be the maximum amount needed to carry out all the rural improvements. The increase in funding when going from Strategy 5 to Strategy 6 is for allowing additional lanes above 12 lanes per facility in urban areas. Therefore, the increased funding of $17.05 billion in Strategy 5 to $19.42 billion in Strategy 6 represents funding spent on adding lanes in urban projects when expanding some existing facilities from 12 to 16 lanes.

Further funding breakdown by functional class and by period, as indicated in Table 10, reveals that among functional class categories, the major part of the funding is invested in the major arterial category in the rural area and the interstate category in the urban area. Comparing across time periods, all functional categories almost invariably receive higher funding for the first period than the second. The only exceptions are the major arterial category in the rural area and collector in the urban area. The most prominent funding investment increases are from the urban interstate and other freeway categories under the unlimited budget strategies of Strategies 5 and 6.

Table 9. Texas Investment Costs of Six Funding Strategies, 1992-2002

Funding Strategy	Investment Cost* 1992-2002, Billions $		
	Rural	Urban	Total
Strategy 1	2.20	3.99	6.19
Strategy 2	3.27	5.99	9.26
Strategy 3	4.38	7.97	12.35
Strategy 4	5.11	9.73	14.84
Strategy 5	5.15	11.90	17.05
Strategy 6	5.15	14.27	19.42

*Investment costs each year are assumed to grow proportionally to traffic growth. Costs are in constant 1992 dollars.

Table 10. Texas Funding Distribution, by Period and by Functional Class, 1992-2002

	First Period Investment Level, 1992-1997, in Billions $					
	Strgy 1	Strgy 2	Strgy 3	Strgy 4	Strgy 5	Strgy 6
Rural						
Interstate	.15	.22	.30	.37	.41	.41
Oth Prin Art	.31	.47	.63	.73	.74	.74
Min Art	.11	.16	.21	.21	.21	.21
Maj Art	.40	.60	.80	.85	.85	.85
Min Col	.16	.24	.32	.39	.42	.42
Total	1.13	1.69	2.26	2.55	2.63	2.63
Urban						
Interstate	.86	1.29	1.72	2.15	4.90	6.48
Oth Exp/Fwy	.57	.86	1.14	1.43	3.12	3.87
Oth Prin Art	.39	.59	.79	.99	1.44	1.45
Min Art	.13	.19	.26	.32	.43	.43
Collect	.10	.15	.19	.22	.22	.22
Total	2.05	3.08	4.10	5.11	10.11	12.45
Overall Total	3.18	4.77	6.36	7.66	12.74	15.08

Table 10. Texas Funding Distribution, by Period and by Functional Class, 1992-2002 (Continued)

	Second Period Investment Level, 1998-2002, in Billions $					
	Strgy 1	Strgy 2	Strgy 3	Strgy 4	Strgy 5	Strgy 6
Rural						
Interstate	.14	.21	.28	.32	.27	.27
Oth Prin Art	.30	.44	.59	.70	.70	.70
Min Art	.10	.15	.20	.25	.28	.28
Maj Art	.38	.56	.75	.92	.97	.97
Min Col	.15	.22	.30	.37	.30	.30
Total	1.07	1.58	2.12	2.56	2.52	2.52
Urban						
Interstate	.81	1.22	1.62	1.99	.19	.21
Oth Exp/Fwy	.54	.81	1.08	1.32	.20	.21
Oth Prin Art	.37	.56	.75	.82	.79	.79
Min Art	.12	.18	.24	.27	.24	.24
Collect	.10	.14	.18	.22	.37	.37
Total	1.94	2.91	3.87	4.62	1.79	1.82
Overall Total	3.01	4.49	5.99	7.18	4.31	4.34

User Costs and Savings

Operating costs, accident costs, and time costs per 1,600 vehicle kilometers traveled for the end year of each analysis period are calculated for each functional class following the same procedures and updating factors used by the Federal Highway Administration [6] and described above. Each is multiplied by the vehicle kilometers traveled for the respective year and functional class, as shown in Table 11, to yield the total operating costs, total accident costs, and total time costs for the end year of each period, and the sum of the three costs constitutes total user costs for the end year of each period. Total user savings are obtained as the difference between the user costs of a funding strategy and the "No Maintenance" strategy. User savings are calculated for rural and urban areas as well as for all areas for the end year in each of the four analysis periods, and these are shown in Table 12. Since service lives of most improvements are considerably longer than the length of all analysis periods combined, improvements made in earlier periods typically give benefits in later periods. Therefore, benefits of improvements accumulate over time, leading to continuously increasing total benefits in later periods, with benefits being greatest in the last period. When comparing rural and urban investments, rural investments produce greater user savings despite the larger funding allocated to urban improvements. This can be explained by large amount of urban investment expended on the improvement of adding lanes which has a very long service life, of 30 to 50 years. Benefits are not completely captured for the entire service lives that are calculated only for the 20 analysis years and the additional five extended years. Incremental user savings are calculated by comparing savings of consecutive strategies to the savings of their previous strategies. Table 13 shows incremental total investments of the six strategies and their incremental user savings of the end year for each of the four periods. Table 14 shows the breakdown of the total investments over all periods of each strategy by two improvement types: (1) added capacity and (2) pavement, reconstruction, and resurfacing, and the incremental investment costs of the two improvement types. The incremental cost breakdown clearly shows as investment increases, most of the additional costs go into urban added capacity improvement projects.

Rates-of-Return

Internal rates-of-return (IRR) of each strategy for rural, urban, and overall area, are calculated using the user savings obtained earlier, daily vehicle-miles traveled, a discount rate of 2.29 percent, and a duration of 25 years. Incremental internal rates-of-return are obtained similarly by replacing user savings with incremental user savings. Table 15 gives the internal rates-of-return and the incremental rates-of-return of the six strategies. Figure 1 illustrates the relationship of the ten year investment costs and the incremental internal rates-of-return for rural, urban, and overall area. Investments for rural area receive the highest incremental rates of return while urban areas receive the lowest.

Table 11. Texas Daily Vehicle Kilometers Traveled, in Millions

	1992	1997	2002	2007	2012
Rural					
Interstate	55.0	61.2	69.2	77.2	85.3
Oth Prin Art	71.3	78.9	88.5	98.2	109.4
Min Art	28.2	30.6	33.8	38.6	41.8
Maj Art	73.1	82.1	93.3	104.6	119.1
Min Col	8.2	9.7	11.3	12.9	14.5
Total	235.3	262.3	296.1	331.5	370.1
Urban					
Interstate	105.4	117.5	130.4	144.8	160.9
Oth Exp/Fwy	66.3	74.0	83.7	95.0	107.8
Oth Prin Art	67.9	75.6	83.7	93.3	104.6
Min Art	17.2	19.3	22.5	25.7	29.0
Collect	8.9	9.7	11.3	14.5	16.1
Total	265.7	296.1	331.5	373.4	418.4
Grand Total	501.5	558.4	627.6	704.9	788.6

Table 12. Texas User Savings of Six Funding Strategies, for 1997, 2002, 2007, and 2012

Funding Strategy	User Savings,* Dollars per 1,600 Vehicle Kilometers			
	1997	2002	2007	2012
Rural				
Strategy 1	56.4	215.6	358.0	382.0
Strategy 2	67.4	253.0	413.0	437.5
Strategy 3	73.6	270.3	441.4	469.5
Strategy 4	76.5	276.6	452.3	484.9
Strategy 5	76.8	276.8	452.6	484.8
Strategy 6	76.8	276.8	452.6	484.8
Urban				
Strategy 1	65.5	202.9	292.5	322.7
Strategy 2	76.3	237.7	343.1	382.0
Strategy 3	83.9	257.6	372.6	420.2
Strategy 4	88.1	265.0	384.9	438.1
Strategy 5	103.1	271.8	391.7	441.5
Strategy 6	103.6	272.9	393.9	445.8
Overall				
Strategy 1	61.3	208.9	323.3	350.6
Strategy 2	72.2	244.9	376.0	408.1
Strategy 3	79.1	263.6	405.0	443.3
Strategy 4	82.7	270.5	416.7	460.1
Strategy 5	90.8	274.2	420.4	461.8
Strategy 6	91.1	274.8	421.5	464.1

*Savings represent savings in the last year of each period when compared with the No Maintenance Strategy in the same period.

Table 13. Texas Incremental Investment Costs and Incremental User Savings of Six Funding Strategies for 1997, 2002, 2007, and 2012

Funding Strateg	Incremental Investment -Billion $-	Incremental User Savings,* Dollars per 1,600 Vehicle Kilometers			
		1997	2002	2007	2012
Rural					
Strategy 1	2.20	56.4	215.6	358.0	382.0
Strategy 2	1.07	11.0	37.4	55.0	55.5
Strategy 3	1.11	6.2	17.3	28.4	32.0
Strategy 4	.73	2.9	6.3	10.9	15.4
Strategy 5	.04	.3	.2	.3	-.1
Strategy 6	.00	.0	.0	.0	.0
Urban					
Strategy 1	3.99	65.5	202.9	292.5	322.7
Strategy 2	2.00	10.8	34.8	50.6	59.3
Strategy 3	1.98	7.6	19.9	29.5	38.2
Strategy 4	1.76	4.2	7.4	12.3	17.9
Strategy 5	2.17	15.0	6.8	6.8	3.4
Strategy 6	2.37	.5	1.1	2.2	4.3
Overall					
Strategy 1	6.19	61.3	208.9	323.3	350.6
Strategy 2	3.07	10.9	36.0	52.7	57.5
Strategy 3	3.09	6.9	18.7	29.0	35.2
Strategy 4	2.49	3.6	6.9	11.7	16.8
Strategy 5	2.21	8.1	3.7	3.7	1.7
Strategy 6	2.37	.3	.6	1.1	2.3

*Savings represent savings in the last year of each period when compared with the No Maintenance Strategy in the same period.

Table 14. Total Investment Costs and Incremental Investment Costs by Improvement Type and by Area Type

Funding Strategy	Investment (million $)		Incremental Investment (million $)	
	Added Capacity	Pavement Reconstruction, Resurfacing	Added Capacity	Pavement Reconstruction, Resurfacing
Rural				
Strategy 1	296	1905	296	1905
Strategy 2	485	2784	189	879
Strategy 3	853	3530	368	746
Strategy 4	1009	4096	156	566
Strategy 5	1013	4146	4	50
Strategy 6	1013	4146	0	0
Urban				
Strategy 1	2874	1115	2874	1115
Strategy 2	4613	1377	1739	262
Strategy 3	6411	1557	1798	180
Strategy 4	7979	1760	1568	203
Strategy 5	10226	1657	2247	-103
Strategy 6	12587	1660	2361	3
Overall				
Strategy 1	3170	3020	3170	3020
Strategy 2	5098	4161	1928	1141
Strategy 3	7264	5087	2166	926
Strategy 4	8988	5856	1724	769
Strategy 5	11239	5803	2251	-53
Strategy 6	13600	5806	2361	3

Table 15. Internal Rates-of-Return (IRR) and Incremental Internal Rates-of-Return on Texas Investments

Funding Strategy	Incremental Investment - Billion $ -	IRR	Incremental IRR
Rural			
Strategy 1	2.20	116.4	116.4
Strategy 2	1.07	102.7	68.9
Strategy 3	1.11	92.7	50.3
Strategy 4	.73	88.8	44.2
Strategy 5	.04	87.7	19.9
Strategy 6	.00	87.7	.0
Urban			
Strategy 1	3.99	96.3	96.3
Strategy 2	2.00	84.3	53.7
Strategy 3	1.98	76.3	42.9
Strategy 4	1.76	69.9	28.1
Strategy 5	2.17	53.6	16.3
Strategy 6	2.37	48.5	4.0
Overall			
Strategy 1	6.19	104.0	104.0
Strategy 2	3.07	91.4	59.7
Strategy 3	3.09	82.7	45.8
Strategy 4	2.49	77.0	32.7
Strategy 5	2.21	62.9	16.4
Strategy 6	2.37	58.2	4.0

Note: Internal rates-of-return are calculated using a traffic growth rate of 2.29 percent and estimated user benefits over a total of 25 years, with user benefits per 1,600 vehicle kilometers in the last five years assumed to be the same as year 20.

Results

The analysis of the impacts of various investment levels on the highway network in Texas shows some interesting results. Each of the limited budget strategies, from 1 to 4, would yield an extremely high return for the investment in highway infrastructure. In Table 15, Strategy 4 has an incremental rate-of-return of 32.7 percent, for both rural and urban areas combined. This funding level would represent a substantial increase in current funding for highways in Texas, and would yield very high benefits for motorists using those highways. A substantial part of that additional funding would go to pavement resurfacing and reconstruction. As can be seen in Table 14, Strategy 4 represents over 4 billion dollars in pavement related expenditures over the 10 year period in rural areas and about another 1.8 billion in urban areas, for a total of about 5.9 billion. About nine billion would be spent on added capacity in Strategy 4.

Strategies 5 and 6 represent unconstrained budget scenarios, with Strategy 5 having a 12-lane restriction and Strategy 6 having a 16-lane restriction. The additional or incremental investment for both of these strategies is almost exclusively for added capacity in urban areas, as shown in Table 14. Strategy 5 has a very favorable 16.3 percent incremental return, with a lower but positive 4 percent for Strategy 6. Strategy 5 represents an investment of over 17 billion dollars over the 10 year period covered by the analysis for added capacity and pavement rehabilitation.

The results of the analysis demonstrate the high return the citizens of Texas could receive by increasing the investment into the state's transportation network. The 16.3 percent annual return for Strategy 5 compares very favorably to current yields on long-term government bonds or spending in other areas by the state. It should be kept in mind that the HPMS analysis package used in this study does not cover all areas of transportation expenditures. For example, it does not cover bridges, highways built on new location, routine maintenance, intersections or interchanges, safety improvements, or any administrative expenses. Therefore, the 17 billion over 10 years estimated for Strategy 5, would be principally for adding capacity on existing highways, pavement resurfacing and reconstruction, and some geometric improvements.

Implications for Bond Financing

The rate-of-return analysis suggests several implications for use of bond financing of State highways in Texas. These results are considered preliminary and will be further studied in the second year of the project. Projections of funds available for contract construction spending in the period from 1992 through 2002 indicate that about $1.4 billion to $1.6 billion will be available in most years. However, it appears that only about $1.0 billion will be available for the types of expenditures included in the rate-of-return analysis. This indicates that funding will be available for Strategy 3 (as shown in the first part of Table 10). Therefore, additional funding from bond financing would give an incremental

rate-of-return similar to that shown for Strategy 4, or over 30 percent per year for the amount of funds used in Strategy 4, or about $0.25 billion per year. The incremental rate-of-return decreases to about 16 percent for Strategy 5. This increment is much larger, however, amounting to about $1.0 billion per year in the period 1992-1997.

Although incremental spending from issuing bonds would initially give very large returns, this would also imply less funding in future years, which would mean giving up even higher returns in future years, when the bonds plus interest would have to be repaid. These types of scenarios will be studied further in the second year of the project.

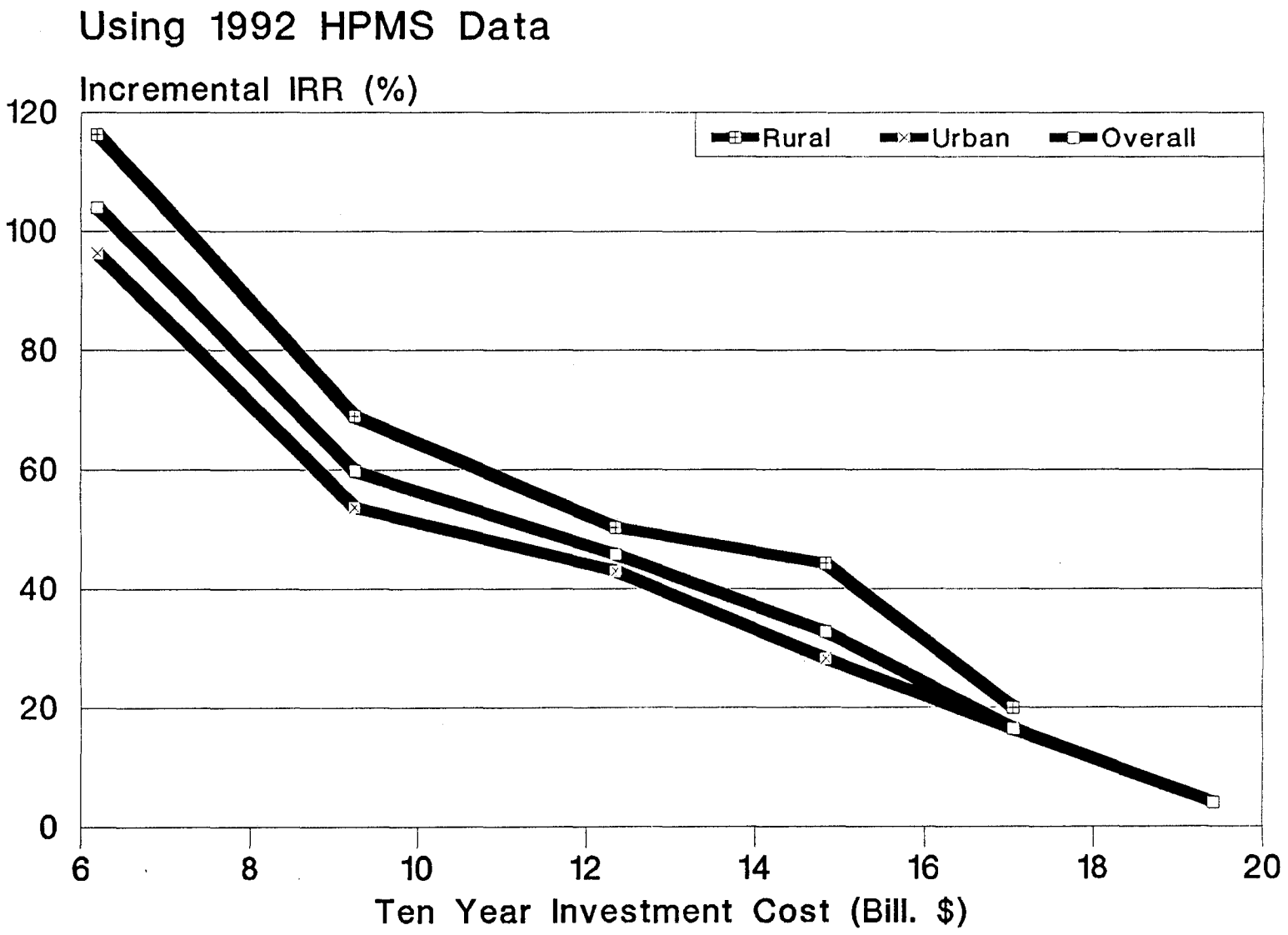

Figure 1. Texas Incremental Internal Rates of Return for Six Funding Strategies

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