

impact statement (EIS); (b) public and local and regional government views, obtained through the same processes; and (c) sometimes, the calculation of delay or safety indices. These are benefit/cost ratios, multiplied by 100 to produce the index numbers, that show the values of expected travel-time savings and of accident cost savings, respectively, in relation to project costs.

A staged development plan is recommended in this study for future determination of HE1 project priorities. Four steps were suggested for the first year:

1. Refine the procedures for computation of the safety and delay indices.
2. Combine the delay and safety indices with a new community-impact index that uses simplified procedures for rating public acceptance, social, environmental, and economic impacts. The resulting priority formula is

$$\text{B/C index} = (\text{delay index})^{1/2} + \text{safety index} + \text{community-impact index} \quad (3)$$

3. Supplement the B/C index by obtaining narrative comments on any other considerations of potential importance to the priority of the project.

4. Test more-detailed procedures for rating community impacts on selected HE1 projects (those that have an EIS) to (a) refine the suggested procedures, (b) compare the refined procedures with the simple procedures suggested for immediate use, and (c) determine the extent to which the community-impact index affects the transportation benefit/cost index in typical projects.

Among the refinements suggested for the delay index are (a) a method for estimating the value of travel time as a function of the amount of time saved (time savings are not valued highly until they exceed about 5 min/trip) and (b) a pricing correction factor to adjust user benefits for the underpricing of highways and their consequent overuse (which creates undue or premature congestion and the associated tendency to overbuild). The pricing correction factor reduces user benefits as a function of the price elasticity of demand for highways, which is a measure of prospective induced

travel—hence, urban highway improvements are more affected by this adjustment than are rural improvements. A parallel measure for new facilities, the tendency to induce residential growth in undesired locations, is included in the proposed community-impact index.

Among the variables considered for inclusion in one of the HE1 indexes, but eventually dropped, was fuel savings. In this case, the net effect will generally be too small to justify the necessary estimates and calculations.

In subsequent years, it will be necessary to decide whether to use the refined procedures for computing the community-impact index, either in general or for projects having an EIS available.

HB4: SYSTEM OPERATION IMPROVEMENTS

HB4 is the largest program component after new highway construction; it uses about 11 percent of the six-year highway capital-outlay budget. It entails increases in the efficiency and quality of traffic service through projects that reduce freeway congestion (such as climbing lanes, high-occupancy-vehicle lanes, priority ramp treatments, and fringe parking facilities), improve freeway traffic service (such as improved lane delineation and signs), and improve conventional highways and expressways (such as traffic signals, left-turn and passing lanes, and shoulder widening). Many of these types of projects have measurable and predictable effects on traffic flow or accident risks, so it is recommended that the delay and safety indices be calculated for all applicable projects and combined in a single criterion, the transportation benefit/cost index, as follows:

$$\text{Transportation B/C index} = \text{delay index} + \text{safety index} \quad (4)$$

For HB4 projects that do not have significant effects on traffic flow or safety, continuation of the present Caltrans effort to develop separate cost-effectiveness indices is recommended.

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Highway Funding: Arizona Case Study

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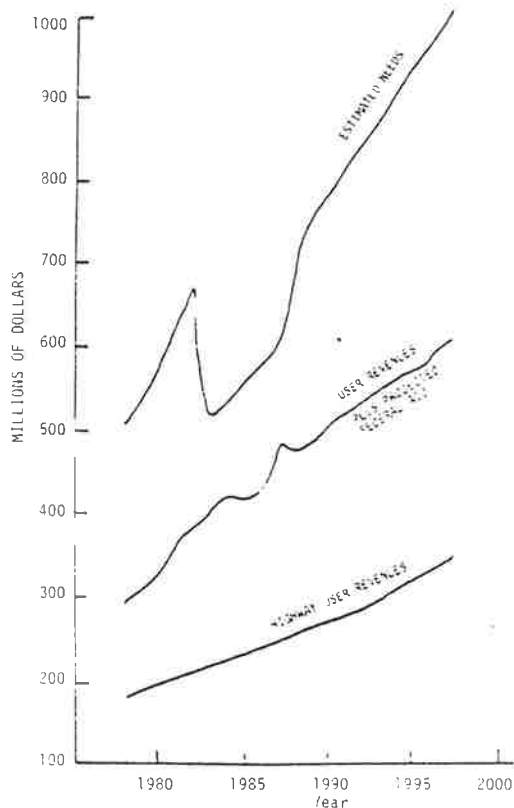
During the summer of 1978, the highway funding situation in Arizona was reviewed and the alternatives for overcoming the anticipated future deficit were studied. Although a number of user, as well as nonuser, revenue sources are potentially available, the emphasis was placed on increasing user charges. Based on this study, it was recommended that revenues be increased by (a) staged increases in the fuel tax, (b) increases in registration fees, and (c) increases in third-structure taxes. In all cases, it was recommended that user taxes be tied to a consumer price index so that additional increases will offset the effect of inflation.

In January 1978, the Arizona Department of Transportation (ADOT) submitted the Biennial Statewide Transportation Needs Report to the state legislature in accordance

with the law passed by the 31st legislature in 1974. This Needs Report represented the culmination of a comprehensive examination of the current estimates of future transportation needs in the state.

Basically, the report indicates that Arizona faces major problems with respect to the funding of the highway system over the next 20 years. Figure 1 illustrates the comparison between the anticipated needs and the funding available from current revenue sources and indicates a considerable deficit. Even though the results of the needs study are considered to be conservative estimates of the resources that will be required, it is expected that the deficit will be at least approximately

Figure 1. Estimated needs and forecast revenues.



\$7.5 billion (based on estimated revenues from the Arizona highway-user revenue fund and projected federal aid). The financial resources from the highway-user fund are used to support highway programs of the cities and counties, ADOT, and the highway patrol activities of the department of public safety (see below).

Item	Percentage of Total
Source of revenue	
Fuel taxes	63
Vehicle registration fees (prorated), weight fees, and nonresident permits	23
Motor carrier (passenger and freight) taxes (gross receipts)	7
License (motorcycle, chauffeur, and operator) fees	2
Other (title, dealer licensing and plates, oversize permit, inquiry and miscellaneous) fees	5
Expenditure	
State highway fund	57
Highways in incorporated cities and towns	17
Highways in the counties	15
Department of public safety	11

Obviously, the lack of sufficient financial resources will affect transportation agencies at all levels of government throughout the state.

The needs study indicated that highway financing in the state should be reviewed and that options that would generate additional revenues for the highway-user fund should be developed. Thus, in response to a request from the state legislature, Arizona State University, Northern Arizona University, and the University of Arizona initiated a study of funding for Arizona highways. The basic purpose of this study was to examine the ways

and means of generating additional funds for the highway-user revenue fund so as to make available the necessary financial resources.

The financial resource requirements as estimated and projected in the Needs Report were used as the basis for the total revenues that will be necessary over the 20-year forecast period. These estimates were accepted as reported; the focus of this project was on the alternatives for generating the required additional revenues. The implications of failure to meet the transportation needs are documented in the needs study and show that there will be serious consequences if the transportation needs are not met.

CURRENT ISSUES

At present, transportation agencies at all levels of government in Arizona are faced with the difficult tasks of maintaining existing highways and providing new facilities in response to public demands. The current highway financing situation poses major problems in terms of the ability of the agencies to carry out their responsibilities for the provision of services to the public. (It is recognized that the problems associated with highway financing are not unique to Arizona but are of concern in almost every state.)

A number of underlying issues bear directly on existing and anticipated future highway financing problems. In many cases, these issues are the result of situations or problems such as energy constraints, growth, economic conditions, and taxation; nevertheless, their impact has been on and potentially will have major implications for the funding of highway facilities.

Effects of Inflation

In the provision of highway facilities and programs, inflation is a major concern because it increases the costs of transportation agency services and facilities. The rate of inflation has increased significantly over the last decade, and current forecasts indicate that this trend will continue. Basically, this means that budgets for highway operations, maintenance, and construction must be increased even if the levels of activities and programs are fixed. If the available financial resources do not permit budgets to be increased commensurate with inflation, then it will be necessary to reduce highway services.

The magnitude of the problem is shown by an examination of the funding requirements as outlined in the Needs Report. In the needs study, the difference between the total 20-year needs and the expected revenue was found to be approximately \$2.4 billion in terms of 1977 dollars. When the effect of inflation is considered, however, the difference is approximately \$7.5 billion for the same period. Thus, inflation alone will cause the deficit to almost triple over the study period.

A review of the major revenue sources for the highway-user revenue fund, however, indicates that these sources are generally insensitive to inflation. The revenue generated is not a function of the price changes for highway services and facilities. Gasoline and use fuel taxes are based on a fixed tax per unit volume, and registration, operator licensing, and weight fees are assessed on a set-fee basis. Thus, the most important sources of revenue do not reflect inflationary conditions, which in view of both current and anticipated future inflation patterns is a major concern.

Increased Fuel Economy

The energy shortage and the continuing concern about

energy have had and will continue to have significant impacts on the highway funding problem. The American public has begun to shift to more fuel-efficient vehicles, and mandates have been imposed that are aimed at increasing the fuel efficiency of future automobiles. It is expected that this trend toward greater fuel efficiency will continue.

Estimates provided by ADOT indicate that the average fuel efficiency for gasoline-powered vehicles in Arizona for 1978 was 5.67 km/L (13.33 miles/gal). By the year 2000, this is expected to improve to 10.42 km/L (24.50 miles/gal). Corresponding estimates for diesel-powered vehicles are 3.53 km/L (8.30 miles/gal) in 1978 and 4.94 km/L (11.60 miles/gal) by the year 2000.

These increases in fuel efficiency are certainly necessary in view of the energy situation; however, improved fuel efficiency means reductions in highway revenue for given levels of vehicle travel. For example, if the fuel efficiencies for the years 1978 and 2000 are compared, the revenues from gasoline taxes will be reduced by almost 50 percent for a given amount of vehicle travel. In essence, the gasoline tax cost per kilometer of travel will be greatly reduced; for use fuel, the situation is similar but of a lesser magnitude.

Highway-User Tax Burden

Transportation systems and facilities are necessary to provide the mobility required for broader societal objectives. In this respect, the need for transportation facilities is a function of the mobility that is required to support socioeconomic activities and, thus, expenditures for transportation facilities should be related to the economic activity of an area.

An examination of the highway-user revenue fund indicates a general decrease in highway-oriented tax revenues relative to personal income in Arizona. For example, the highway-user revenue fund was 1.45 percent of personal income in FY 1961, increased to 1.74 percent in FY 1967, and then decreased to 1.29 percent in FY 1974 when a motor-fuel tax increase increased the percentage slightly; however, it is estimated that in FY 1978 the highway-user revenue fund revenues were 1.23 percent of personal income. During a time when the overall tax burden has increased relative to personal income, the highway-oriented tax burden has decreased.

Another measure of the highway-user tax burden is the tax revenue relative to vehicle kilometers of travel. Again, there has been a general decrease in the tax burden relative to travel. For example, if the highway-user revenue fund revenue per vehicle kilometer traveled for FY 1978 is compared with that for FY 1974, there is an approximately 16 percent decrease in the tax burden. Although the public is traveling more, the tax burden on a distance-traveled basis is decreasing. ↵

State Spending Limitations

In the November 1978 election, the voters approved a referendum that limited state spending in a given year to 7 percent of total personal income. The types of problems that this restraint places on state agencies are being recognized; however, the full ramifications of the limit may not be fully understood for several years.

The state is approaching or may have reached the limit already. The effect on highway spending is fairly obvious; the needs gap cannot be closed by increasing highway revenues unless there is also a substantial reallocation of funds or a reduction in some other agency spending. Because of the magnitude of the added revenues that are required to fill the highway needs, it is doubtful that closing the gap will be possible unless ex-

penditures are reallocated.

Beyond the obvious problem of restraints on expenditures, there are more subtle issues surrounding the 7 percent spending limit and the relationship with highway finance. Possibly the most important of these is that ADOT will be limited in its ability to catch up in high-revenue years on maintenance or construction that had been deferred during low-revenue years. Under the mandate, funds will be appropriated for ADOT each year, and only that amount can be spent. If highway revenues exceed appropriations, the excess funds are put aside to be appropriated the following year. Given that the costs of road maintenance and road construction increase over time due to both inflation and the additional wear on existing roads, this constraint represents an inefficient use of highway funds.

Inadequate Funding

In addition to the tax burden, highway users must also pay the operating and maintenance costs of their vehicles. Poorly maintained highways result in increased vehicle operating and maintenance expenses. For example, tire wear, suspension system wear and damage, and fuel use all tend to increase as the condition of the roadway is degraded. Also, accidents increase, which again increases the user cost for a facility, due to accident and insurance costs.

If adequate maintenance funds are not available, transportation agencies may be forced to delay necessary maintenance activities. In using such a practice, the agencies risk dramatic increases in the cost of restoring the roadway at a later date. Although delays in maintenance activities may contribute to short-term budget reductions, they can be expected to increase the overall cost of providing serviceable roadways.

The needs study cost estimates assumed timely maintenance programs; thus, if maintenance activities are deferred, these estimates will have to be significantly increased. At the same time, a reduction in the efficiency of the highway system, whether from inadequate maintenance or lack of adequate facilities, results in an economic ripple across the entire economy—road-user costs increase, the costs of goods and services (which include transportation costs) increase and, ultimately, almost all costs increase.

Similar increases in cost to the road user can be expected if highway development fails to keep pace with the growing demands for travel and improved facilities that are caused by population and economic growth. In this case, the added cost can be attributed to congestion, delay, and accidents. The road user, therefore, is placed in the position of supporting the cost of highway construction, maintenance, and operation. If adequate funding is not provided, the road user suffers the increased costs associated with inadequate or poorly maintained facilities.

These increased costs are also passed on to the non-user as well, because transportation costs are included in the production and distribution of goods and services. Thus, adequate transportation facilities are of interest to society as a whole as well as to the road user. It may be said, therefore, that the citizens of Arizona will pay the total cost of highway transportation in one way or another. If adequate funding for highway construction, maintenance, and operations is not available, then the added costs will be paid in the form of additional vehicle operating and maintenance costs, time delay costs, and insurance premiums.

HIGHWAY FUNDING ALTERNATIVES

Funding alternatives of highways must ensure that the current issues associated with highway financing are addressed. In this respect, they must be sensitive to the effects of inflation, and the recommended solution should contain a mechanism that accounts for both inflation and deflation of construction, operation, and maintenance costs. At the same time, the solution should overcome the deficiencies in highway funding, both current and projected, and the requirements for new highway development due to increased travel should be accommodated. The change in vehicle technology with respect to fuel use poses new problems in terms of the current heavy reliance on motor-fuel tax revenues. All of these aspects of the overall problem must be considered, even with the restraints that have been placed on taxing and spending in Arizona.

Approaches to Overcome Effects of Inflation

There are two approaches that could be used to offset the effects of inflation with respect to highway revenues. The first would be to apply a cost or price index to some revenue base so that tax rates would be adjusted according to the price or cost index. In this way, revenues would increase or decrease based on price or cost changes. Ideally, highway-user tax rates should be adjusted according to a construction cost index. A consumer price index (CPI) is being developed for Arizona, and it may be possible to apply this index to highway-user changes. The use of a CPI has the advantage of being accepted for other applications in the state, and the use of a common index would simplify the situation.

The second approach to offsetting the effects of inflation would be to establish the level of highway funding as a percentage of personal income. Generally, this would have the same effect and would adjust revenues on a basis of personal income changes, provided those changes were directly related to inflation.

Both approaches would require initial increases in revenue to overcome the current deficiencies in funding. But once that was achieved, the indexing scheme would provide for increases in revenue to overcome the price or cost changes.

Period of Implementation

Although the needs study indicates a current deficiency in terms of available revenues, it is reasonable to expect that transportation agencies would require a transition period to prepare for programs that are commensurate with higher levels of funding. Because of the magnitude of the current deficit, a period of several years would be necessary, during which it would be necessary to increase revenues to overcome the deficiencies and to modify the programs to account for inflation.

During the transition period, some needs will not be met. It will be necessary for transportation agencies to reassess impacts on anticipated needs where programs must be delayed due to inadequate funding. It is likely that future needs will increase and that the funding levels will have to be increased accordingly.

Funding Source Alternatives

There are two general options that could be pursued relative to providing highway funding in Arizona. The first is to modify the current tax and fee structure of the highway-user revenue fund. The second is to supple-

ment or replace the current funding structure with taxes and revenues from new sources.

Modification of the existing tax and fee structure would not require new taxes. All highway-user taxes such as fuel, registration, weight fees, and such would be increased. This would distribute the increase to all groups of road users and could be done so that the increase would affect all classes of road users in the same manner. Alternatively, some rather than all taxes could be increased. Taxes could also be increased by stages as the needs increase.

New revenue sources could be either new taxes or the allocation of existing tax monies from the general fund into the highway-user revenue fund. The main problem with this approach is that general fund monies available for other purposes would be decreased unless other (non-highway) tax rates were increased. The use of the general fund as a source of additional highway funds would require no increase in the tax collection administrative structure.

The new-tax option would require the enactment of new taxes. A new tax or taxes should be highway-user oriented to maintain the user-benefit concept. Any new tax should be readily identifiable as a tax on highway users.

A combination of general fund diversion and current tax modification is also possible. This approach would tend to mitigate the unattractive features of each. The administrative costs of tax collection would not increase, and the realization that everyone benefits from the highway system would reinforce the user-tax concept.

In the course of the study, the following revenue alternatives were selected for detailed examination:

1. Gasoline and use taxes (increases in the volume-based tax, sales taxes on the nontax price, taxes based on a percentage of price, and variable fuel taxes),
2. Motor vehicle license (in lieu of personal property taxes),
3. Sales taxes on automobile-related sales,
4. Sales taxes on private sales of automobiles,
5. Vehicle registration fees,
6. Motor carrier taxes (third-structure taxes),
7. Lodging taxes,
8. Bonding, and
9. Taxes on increases in property value due to highway improvements.

CONCLUSIONS AND RECOMMENDATIONS

Based on the study of the various tax alternatives, it was concluded that the state should maintain the user-tax concept for highway funding. Although no tax is popular, the user-tax concept appears to be acceptable if the need for revenue is properly identified. The user tax appears equitable, that is, those who benefit should be prepared to pay the cost of that benefit, an idea that was included in the recommendation by increases in taxes for all groups of road users by approximately the same rates as under the existing tax structure.

The recommended package includes increases in the fuel tax, automobile registration fees, truck weight fees, and the various truck permits and is as follows:

1. First year: The fuel tax should be increased \$0.0026/L (\$0.01/gal), vehicle registration fees (private automobiles and trucks) should be increased \$8.00, and truck weight fees and associated prorated and permit fees should be increased 10 percent. All of these taxes should be tied to the CPI and adjusted annually.
2. Second year: The fuel tax should be increased \$0.0026/L in addition to any change indicated by the CPI.

3. Third and fourth years: The fuel tax should be increased \$0.0026/L, if necessary to close the gap between identified needs and revenues, in addition to any change indicated by the CPI.

The forecast revenue under the recommended plan and the needs in five-year increments are compared below.

Period	Needs (\$ millions)	Federal Aid Plus Revenue (\$ millions)	Needs Met (percentage of total)
1978-1982	2945.3	1892.4	64.3
1983-1987	2827.5	3010.1	106.5
1988-1992	3966.5	3580.2	90.3
1993-1997	4734.7	4759.5	100.5

The rationale for the recommended package includes all of the factors discussed above. The user concept is maintained in the package by using the existing road-user tax structure. This also means that the collection machinery already exists; no significant new administrative organization is required, which will minimize administrative costs. The package provides for the effect of inflation by tying the user taxes to automatic changes in the state CPI (which will be prepared regularly). This is an important feature because the current user-tax structure is not responsive to inflation. The first-year increase will bring the tax rate to where it would have been if highway-user taxes had been tied to the inflation rate since the last fuel-tax increase in 1975. Population growth and travel are accounted for by increases not only in the fuel tax but also in vehicle registration and truck fees.

The taxes are spread over a broader base. This feature of the package reduces the reliance on the fuel tax as the primary source of revenue. Because of the technological changes that are occurring, proportionally less income will be realized from the fuel tax.

(Because the federal government is currently carrying out a weight allocation study to determine the effects of

heavy trucks on highway costs, weight fees were not discussed in this report; the entire problem of weight allocation costs should be reviewed when the federal study has been completed.)

The opportunity for periodic review is a feature of the recommended package. Because the transition period for implementation covers several years, it will be possible to review needed increases in light of updated needs studies.

Because of the transition-period feature, the first-year increase to users will be approximately \$16/passenger-type vehicle or about 10 percent. The transition period will allow for timely planning by the various highway agencies that use the funds and permit a gradual increase in state highway spending with respect to personal income.

It should be noted that these recommendations are specific for the state of Arizona. Although many states currently face funding problems, it is not possible to set forth recommendations that would be applicable to the travel and taxing situations in all states. This study did provide a set of recommendations that would address the problems in Arizona.

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Methodology for Evaluating Impacts of Energy, National Economy, and Public Policies on Highway Financing and Performance

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The need to conserve energy, inflationary pressures, decreasing user tax revenues, and recent national automotive policy decisions have created problems that have seriously affected the state highway financing process. This paper discusses the development and application of a computer model that can be used to analyze and estimate the complex interactions among the factors influencing highway financing and their ultimate impacts on highway performance. The model uses the national energy and economic forecasts developed by Data Resources, Inc., along with a set of possible highway policy options, and simulates their effects on factors such as vehicle fuel efficiency, commercial and noncommercial vehicle travel, fuel consumption, revenue generation, and highway

maintenance and capital expenditures. Application of the model to the Indiana problem indicated that an overall deterioration in highway performance can be expected because the revenue required to stabilize or improve highway performance is enormous. However, the scenarios tested showed that highway policy options such as revised highway performance criteria and programs to reduce future highway use can have a significant impact on future highway performance. Thus, combinations of increased tax rates and non-revenue-generating highway policy options may be necessary to ensure the sustenance of a tolerable level of highway performance in the future.