NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM
SYNTHESIS OF HIGHWAY PRACTICE 72

TRANSPORTATION NEEDS STUDIES AND FINANCIAL CONSTRAINTS

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL

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RESEARCH SPONSORED BY THE AMERICAN ASSOCIATION OF STATE HIGHWAY AND TRANSPORTATION OFFICIALS IN COOPERATION WITH THE FEDERAL HIGHWAY ADMINISTRATION

SUBJECT AREAS

PLANNING
FORECASTING
FINANCE

MODES

HIGHWAY TRANSPORTATION
PUBLIC TRANSIT
RAIL TRANSPORTATION
AIR TRANSPORTATION
OTHER (bicycle, pipeline, pedestrian, waterways, etc.)

TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
WASHINGTON, D.C.

OCTOBER 1980

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

Systematic, well-designed research provides the most effective approach to the solution of many problems facing highway administrators and engineers. Often, highway problems are of local interest and can best be studied by highway departments individually or in cooperation with their state universities and others. However, the accelerating growth of highway transportation develops increasingly complex problems of wide interest to highway authorities. These problems are best studied through a coordinated program of cooperative research.

In recognition of these needs, the highway administrators of the American Association of State Highway and Transportation Officials initiated in 1962 an objective national highway research program employing modern scientific techniques. This program is supported on a continuing basis by funds from participating member states of the Association and it receives the full cooperation and support of the Federal Highway Administration, United States Department of Transportation.

The Transportation Research Board of the National Research Council was requested by the Association to administer the research program because of the Board's recognized objectivity and understanding of modern research practices. The Board is uniquely suited for this purpose as: it maintains an extensive committee structure from which authorities on any highway transportation subject may be drawn; it possesses avenues of communication and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to its parent organization, the National Academy of Sciences, a private, nonprofit institution, is an insurance of objectivity; it maintains a full-time research correlation staff of specialists in highway transportation matters to bring the findings of research directly to those who are in a position to use them.

The program is developed on the basis of research needs identified by chief administrators of the highway and transportation departments and by committees of AASHTO. Each year, specific areas of research needs to be included in the program are proposed to the Academy and the Board by the American Association of State Highway and Transportation Officials. Research projects to fulfill these needs are defined by the Board, and qualified research agencies are selected from those that have submitted proposals. Administration and surveillance of research contracts are responsibilities of the Academy and its Transportation Research Board.

The needs for highway research are many, and the National Cooperative Highway Research Program can make significant contributions to the solution of highway transportation problems of mutual concern to many responsible groups. The program, however, is intended to complement rather than to substitute for or duplicate other highway research programs.

NCHRP SYNTHESIS 72

Project 20-5 FY 1979 (Topic 11-01)
ISSN 0547-5570
ISBN 0-309-03152-4
Library of Congress Catalog Card No. 80-54634

Price: $6.40

NOTICE

Published reports of the

NATIONAL COOPERATIVE HIGHWAY RESEARCH PROGRAM

are available from:

Transportation Research Board
National Academy of Sciences
2101 Constitution Avenue, N.W.
Washington, D.C. 20418

Printed in the United States of America.

PREFACE

There exists a vast storehouse of information relating to nearly every subject of concern to highway administrators and engineers. Much of it resulted from research and much from successful application of the engineering ideas of men faced with problems in their day-to-day work. Because there has been a lack of systematic means for bringing such useful information together and making it available to the entire highway fraternity, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize the useful knowledge from all possible sources and to prepare documented reports on current practices in the subject areas of concern.

This synthesis series attempts to report on the various practices, making specific recommendations where appropriate but without the detailed directions usually found in handbooks or design manuals. Nonetheless, these documents can serve similar purposes, for each is a compendium of the best knowledge available on those measures found to be the most successful in resolving specific problems. The extent to which they are utilized in this fashion will quite logically be tempered by the breadth of the user's knowledge in the particular problem area.

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of special interest and usefulness to transportation planners and administrators who must use needs studies as a basis for developing programs within constrained financial resources. A procedural framework is presented for estimating transportation needs and making decisions on funding.

Administrators, engineers, and researchers are faced continually with many highway problems on which much information already exists either in documented form or in terms of undocumented experience and practice. Unfortunately, this information often is fragmented, scattered, and unevaluated. As a consequence, full information on what has been learned about a problem frequently is not assembled in seeking a solution. Costly research findings may go unused, valuable experience may be overlooked, and due consideration may not be given to recommended practices for solving or alleviating the problem. In an effort to correct this situation, a continuing NCHRP project, carried out by the Transportation Research Board as the research agency, has the objective of synthesizing and reporting on common highway problems. Syntheses from this endeavor constitute an NCHRP report series that collects and assembles the various forms of information into single concise documents pertaining to specific highway problems or sets of closely related problems.

High inflation rates have caused costs for construction, maintenance, and operation of transportation facilities to increase more rapidly than revenues. To operate within available funding limits, many states have been forced to reduce the magnitude of programs and levels of service. This report of the Transportation Research Board focuses on the use of needs studies as a basis for developing programs within constrained financial resources. Guidance and procedures are provided for the following aspects of transportation needs studies and financial constraints: (a) techniques for estimating needs; (b) criteria for developing program packages; (c) considerations in making tradeoffs among geographical, modal, political, and other options; (d) techniques for documenting funding deficiencies to increase awareness of the public and political decision makers; (e) identification of potential sources of additional revenue; and (f) methods of "downscoping" proposed projects.

To develop this synthesis in a comprehensive manner and to ensure inclusion of significant knowledge, the Board analyzed available information assembled from numerous sources, including a large number of state highway and transportation departments. A topic panel of experts in the subject area was established to guide the researcher in organizing and evaluating the collected data, and to review the final synthesis report.

This synthesis is an immediately useful document that records practices that were acceptable within the limitations of the knowledge available at the time of its preparation. As the processes of advancement continue, new knowledge can be expected to be added to that now at hand.

CONTENTS

ACKNOWLEDGMENTS

This synthesis was completed by the Transportation Research Board under the supervision of Paul E. Irick, Assistant Director for Special Projects. The Principal Investigators responsible for conduct of the synthesis were Thomas L. Copas and Herbert A. Pennock, Special Projects Engineers. This synthesis was edited by Nancy A. Ackerman.

Special appreciation is expressed to Thomas F. Humphrey, Consultant, Hingham, Massachusetts, who was responsible for the collection of data and the preparation of the report.

Valuable assistance in the preparation of this synthesis was provided by the Topic Panel, consisting of Dan C. Dees, Deputy Director of Planning and Programming, Illinois Department of Transportation; Clarence W. Friesen, Chief, Program Management Division, Office of Highway Planning, Federal Highway Administration; Arthur G. Hull, Director of Administration, Vermont Agency of Transportation; Hal Kassoff, Director, Office of Planning and Preliminary Engineering, Maryland State Highway Administration; C. Ian MacGillivray, Director, Planning and Research Division, Iowa Department of Transportation; Marshall F. Reed, Jr., Transportation Engineer, Highway Users Federation for Safety and Mobility.

Kenneth E. Cook, Transportation Economist, Transportation Research Board, assisted the Special Projects Staff and the Topic Panel.

Information on current practice was provided by many highway and transportation agencies. Their cooperation and assistance were most helpful.

TRANSPORTATION NEEDS STUDIES AND FINANCIAL CONSTRAINTS

SUMMARY

Transportation needs studies are conducted by all states. Many states appear to be satisfied with their procedures and the results of their studies; however, often within a particular state, there is disagreement among officials concerning the most appropriate techniques for conducting needs studies and the application of such studies. Although there is no "typical" needs study, the studies used throughout the country display many similarities. Some are sophisticated, making use of continuing updates of computerized data and various computerized models to forecast and analyze the data; others are relatively simple, using minimum amounts of data or models. Most lie between these two extremes.

Transportation needs studies can be used to accomplish numerous objectives, including:

- Providing the technical data needed to determine transportation investment levels for capital, maintenance, and operating needs;
- Justifying the initiation of new projects;
- Justifying the expenditure of funds at desired program levels;
- Identifying and evaluating the relation among transportation, land use, and various other interrelated programs;
- Identifying projects that qualify for reconstruction rather than routine maintenance; and
- Providing a basis for making tradeoffs between programs and program funding levels.

The critical issue that is the focus of this synthesis is how needs studies are used as the basis for developing programs within constrained financial resources. Included in the evaluation of this issue is the manner in which tradeoffs are made between various capital, maintenance, and operating alternatives.

The administrators of state transportation programs are very concerned that at current rates of taxation, traditional sources of revenues for transportation programs are not producing the funds considered necessary to meet minimum needs. Thus a choice must be made: (a) reduce the magnitude of new programs, maintenance, and operations to fit the budgets available; or (b) provide the documentation needed to persuade the governor, the legislature, and the citizens of the state that additional funds are necessary.

The shortage of funds is not necessarily caused by the desire to construct numerous new projects or to substantially increase maintenance efforts. The costs of construction, maintenance, and operations have increased more rapidly than the collected revenues because of large increases in the rate of inflation. Thus simply to maintain previous levels of services and programs requires increases in tax rates. Because new funds from increased taxes have not been forthcoming in many states, there has been a need in the past several years to reduce the magnitude of programs and levels of service in order to operate within available funding limits.

Based on interviews with state officials and a review of material gathered from 18 states, the following conclusions were reached.

TRANSPORTATION NEEDS STUDIES PROCEDURES

The purpose of a needs study and the anticipated use of the results must be clearly understood by both the people who perform the study and those who will make use of the results.

Traditional transportation design standards may have to be reduced (within the limits of safety) to allow for necessary reconstruction and rehabilitation within the constraints of limited funding, which will require a reassessment of current standards and substantial additional study.

Needs studies often have not adequately considered bridge failures, pavement and subbase failures, and the structural integrity of the overall highway system. Most states have a comprehensive highway inventory data base, usually stored on a computer file, which is potentially very useful—if it is used and kept up-to-date. Separate needs studies must be done for each mode because of the unique requirements and funding sources available for each mode.

Needs studies must produce results that are both understandable and believable. The technical procedures used to estimate transportation needs vary from state to state; however, it is not important which procedure is used, but how the results of the study are used.

USE OF TRANSPORTATION NEEDS STUDIES RESULTS

In developing balanced programs (i.e., balancing needs with funds), a solid data base and appropriate analyses must accompany the recommendations on funding levels. The results of needs studies, regardless of how they are accomplished, must be written in clear, concise language. Without effective communication between technical personnel and the governor, legislature, and citizens, it will be impossible to present convincing arguments for the importance of high-priority problems and the need for adequate funding.

When presenting options within program categories, it is important to clearly describe which programs or projects can be included and which ones will be excluded or dropped. There is a consensus that it is essential for all legitimate interests, geographic areas, and program categories to be treated equitably. This cannot happen each year, but must occur over some longer period of time. It is necessary to develop realistic long-range estimates of needs, which will add perspective and understanding to the shorter-term funding problems.

The results of needs studies provide a basis for establishing transportation priorities. The priorities must be established in consultation with citizens, the legislature, and public and private interest groups.

When it is impossible to provide additional funds for projects considered essential by transportation agency personnel, one or more of the following options must be chosen:

- Reduce the number of projects to be funded,
- Reduce design standards, or
- Downgrade projects (e.g., from a freeway to an arterial).

FUNDING DECISIONS

The best-conceived or most soundly documented argument does not necessarily determine the nature or the magnitude of final funding decisions. Many factors must be considered, and they may be virtually impossible to document or quantify.

When new or additional funds are needed, the amount of money obtained may have no direct relationship to the technical analysis that was performed to justify such an increase. The amount allocated will be determined through negotiations and compromises, involving many participants, and within the state's political process.

More consideration must be given to the need for substantially improved maintenance of existing transportation systems. An increasing number of states have concluded that, within existing constraints of state funding, it will be necessary to stop matching some federal programs in order to have adequate funds for 100 percent state-funded maintenance and operating programs. In past years the inability to increase state funds resulted in less funds for maintenance programs. This happened because of the higher priority assigned to matching all available federal programs. These priorities are now starting to shift as more recognition is given to the declining physical stability of the existing transportation network.

The ability to implement programs that have been selected represents a major part of the credibility of the entire process. If possible, a realistic and credible 5- to 10-yr program should be developed so that longer-term and continuing priorities can be established. This should be done with enough flexibility to allow for necessary adjustments based on continuing updates.

In determining which projects and programs are to be funded and the program levels required, as much information as possible must be gathered and analyzed to determine:

- Impacts of taking specific actions,
- Impacts of not taking those actions,
- Long-term impacts of short-term decisions (and short-term impacts of long-term decisions), and
- The benefits and costs of alternatives when choices exist.

The emphasis on highway programs has shifted from construction of interstates and expressways to preserving and maintaining existing facilities at a pace sufficient to prevent the need for major reconstruction and to maintain safe conditions. In this regard, increasing maintenance needs and rapidly rising costs will force the use of construction funds for maintenance purposes.

TRANSPORTATION NEEDS STUDIES PARTICIPANTS

There are numerous private and public participants (both agencies and individuals) involved with defining transportation needs to fit constrained financial resources, each having a different perspective on the same problems and using different criteria to set priorities. All these interests must be balanced. The state legislature is a key participant and must be involved in every step of the process.

CHAPTER ONE

INTRODUCTION

BACKGROUND

There are many technical publications that describe the process and procedures used to estimate transportation needs and to develop short- and long-range programs based on such estimates. This process must be accomplished in a logical, consistent, and systematic way so that the most cost-effective transportation systems possible can be built, operated, and maintained in every state.

The existing procedures have evolved from the increasing sophistication and technical expertise at all levels of government. One of the first definitive summary reports on the subject of transportation needs studies was *NCHRP Synthesis 15 (1)*, published in 1972, which summarized the state-of-the-art at that time. In February 1974, the Transportation Research Board (TRB), in cooperation with the U.S. Department of Transportation (DOT), sponsored a conference in Williamsburg, Virginia, on "Issues in Statewide Transportation Planning." At that conference technical procedures used in statewide transportation planning and programming were critically evaluated, which resulted in a series of recommendations for improving the entire process (*2*). In March 1975, TRB and DOT sponsored a related conference in Orlando, Florida, on the "Transportation Programming Process," which resulted in the publication of *TRB Special Report 157 (3)*. Several research reports were developed from the results and recommendations of the two conferences (*4–7*).

NCHRP Synthesis 48 (6) provides a logical and systematic overall structure for programming transportation projects. A discussion of techniques and procedures for implementing several of the key steps outlined in *NCHRP Synthesis 48* is included in this synthesis. The state-of-the-art is also updated, based on information obtained from personal contacts and documented procedures currently used by 18 states in dealing with the difficult problems encountered in attempting to define transportation needs within severely constrained financial resources. Detailed descriptions of relevant technical procedures are contained in *NCHRP Report 179(4)* and *NCHRP Report 199 (5)*.

Most state transportation and highway agencies are faced with the need to either (a) reduce the magnitude of programs that may have been planned or proposed, (b) find additional sources of revenue, or (c) abandon badly deteriorated bridges and highways. *NCHRP Synthesis 62 (7)* describes available revenue sources and related problems and opportunities. The present synthesis updates previously published work by adding information, gives another perspective based upon current experiences, and aids readers in the selection of the techniques and procedures most appropriate for their own situations by referencing existing technical documents. It is important to keep in mind that the states, and each jurisdiction within a state, have their unique problems, traditions, and available solutions; it is hoped that this synthesis will assist in the exchange of this information.

PURPOSE OF SYNTHESIS

For several decades state highway and transportation agencies have been conducting needs studies in order to provide a factual, logical, and consistent basis for estimating the resources needed to provide the transportation services and facilities for the safe and efficient movement of people and goods.

Highway needs studies traditionally have relied on modern design and program performance standards as the basis for estimating project or system deficiencies. The difference or gap between the standards and actual transportation facilities represented a "need." When unrealistic or overly optimistic "standards" were used, this approach resulted in enormous dollar estimates of future needs that were often unrealistic. Frequently, it was difficult to comprehend the significance of such estimates. In many states the value of an expensive and time-consuming needs study has often been questioned, especially in recent years as more states are having difficulty raising enough revenue to finance critical short-term capital and maintenance needs.

Highway needs studies were the forerunners of transportation needs studies covering all modes of travel. The determination of "needs" for urban transit, air, water, and rail facilities has become an important element in the transportation planning process, especially as more states establish departments of transportation that have multimodal responsibilities. The techniques used to determine needs for those modes have been less rigid and perhaps less complicated to apply because of the more concentrated location of facilities and the relatively smaller number of projects and programs. However, philosophies and techniques similar to those used for estimating highway needs have often been used, sometimes resulting in unrealistic estimates.

State DOTs use completed analyses of transportation needs in a variety of ways; however, the chief purpose of these analyses is for documentation in selling a program or package of programs for approval by the governor, the legislature, and sometimes the voters of the state.

During recent years it has become apparent in many

states that the traditional procedures for estimating transportation needs and using these analyses must be examined and modified—perhaps significantly. Among the many reasons for this reassessment is the overriding problem of financial constraints that have been imposed on the public management of transportation programs. The following factors have contributed to this problem:

- Inflation has more than doubled the cost of construction and maintenance during the past 10 years.
- Revenues have not kept pace with rising costs. In fact, revenues from motor fuel taxes have started to decline in many states as a result of transportation energy conservation programs [most notably the corporate average fuel economy (CAFE) requirements for new automobiles established by the Energy Policy and Conservation Act of 1975]. In some states it has been necessary to reevaluate the priorities on the use of 100 percent state funds.
- After two decades during which new construction was viewed as the major focus of highway programs, the nation's highways are now starting to show the results of inadequately funded maintenance programs. Some states have reached or are on the verge of reaching the point where it may be difficult to match all available federal funds for highway construction programs because such a large proportion of available state revenues must be used for maintenance purposes. Urban transit and intercity rail facilities suffer from the same problem.
- There has been growing involvement of state governments in the financing and operation of all modes of transportation.
- More attention is being given to transportation system management (TSM) projects and the rehabilitation of existing transportation facilities as alternatives to new construction.
- There has been increased pressure to consider the air quality, energy, and social impacts of proposed transportation improvements.
- Public scrutiny of physical and social service investments is on the increase.
- In states that have dedicated highway funds (which in earlier years had been adequate), there is increasing pressure to use general revenue funds for transportation programs. This has resulted and will continue to result in the need for making tradeoffs between transportation and other state programs such as health, education, and other capital and social programs.
- State legislatures are analyzing transportation needs and programs in a more comprehensive manner compared to past practices. State legislators appear to be more interested in the process; many have developed expertise in the subject.

There is a consensus that state transportation agencies must develop more realistic and better documented estimates of transportation needs on which to base requests for funds needed to maintain the quality of the nation's transportation system. The purpose of this synthesis is to provide *guidance* in the following areas:

1. Given constrained financial resources, what are the most appropriate techniques to realistically estimate transportation needs?
2. Assuming that needs will always exceed available resources, how are transportation program packages and options developed and what criteria are used in developing those packages?
3. How are tradeoffs made (when necessary) on the following kinds of options: (a) within transportation program categories, (b) maintenance versus new construction for all modes, and (c) geographic distribution of funds by political jurisdiction within a state to achieve equity?
4. If a state determines that funds from existing revenue sources are not adequate to meet minimum acceptable program needs, what techniques and procedures are used to (a) document funding deficiencies; (b) convince the public, the legislature, and the governor that additional revenues are needed; and (c) identify the services and quality of facilities that may have to be sacrificed?
5. Which sources of new or additional revenues are the most promising?
6. Is it reasonable and possible to consider the "downscoping" of proposed projects as an option when funds are inadequate? If so, what standards can be used to satisfy federal, state, and overall safety requirements?

It is important to acknowledge that not all states are dissatisfied with their current procedures for estimating transportation needs. Obviously, conditions, resources, and traditions are different in every state. The purpose of this synthesis is to focus on appropriate techniques for developing more realistic needs estimates, which can then form the basis for obtaining support to fund the highest-priority transportation programs in a state.

HIGHWAY NEEDS STUDIES AT THE FEDERAL LEVEL

Senate Joint Resolution 81, Public Law 890139, enacted in 1965, directed the biennial reporting to Congress of estimates of the future highway needs of the nation. This legislation constituted the initial mandate for evaluating nationwide highway conditions and investment needs.

Over the past decade, the needs reports to Congress were based on a variety of special national studies that had certain similarities but employed different analytical approaches and resultant themes. Of particular importance is the evolutionary process that has taken place in terms of the definition and assessment of transportation needs.

The first report (in 1968) was based on a series of special studies conducted by the Federal Highway Administration (FWHA) using available data. The report provided tentative information on the existing highway systems, on current highway deficiencies, and on estimated future deficiencies through 1985; explored several federal-

aid program alternatives that might be used to help overcome the deficiencies; recommended studies to redefine the federal-aid systems and to enable economic analyses to determine how and where the investment of federal funds would be most beneficial for national objectives; and focused greater attention than in the past on the improvement of urban transportation.

The 1970 nationwide highway functional classification study constituted the first major special study to collect detailed functional system information on a nationwide basis. All existing public roads and streets, except for the interstate system, were classified without regard to federal-aid system or jurisdiction.

The 1972 report (which covered the time period from 1970 to 1990) combined a projected functional classification for 1990 with a detailed inventory and needs estimate for all functional classes, including local roads and streets. This study, requiring a large data collection effort by the states, provided a description by functional system of the existing road and street network and the traffic using it and existing and future deficiencies on the projected 1990 highway system, using nationally uniform criteria and estimated costs to provide highway services for a projected 20-yr travel demand to the standards specified in the study. Resultant cost estimates clearly exceeded funding levels that could reasonably be expected to be made available, indicating that careful analyses of priorities, program emphasis, adequate performance levels, etc., were in order.

The 1974 report updated the 1972 study. Although the basic travel projections were the same as in the 1972 report, alternatives with reduced travel were also analyzed. Functional classification data were reported by jurisdictional responsibility and by standard metropolitan statistical area (SMSA).

Analytical results of the 1976 National Highway Inventory and Performance Study (NHIPS) were reported to Congress in the 1977 report titled "The Status of the Nation's Highways: Conditions and Performance." The NHIPS report consisted of the collection of two basic types of data: (a) realigned functional system mileage and travel estimates; and (b) sample inventory data on the realigned functional systems.

The analytical approach applied to NHIPS data and the theme adopted for the 1977 report were based on the concept of performance-related investment, and were stimulated by the need to concentrate highway program investments in the areas of highest priority. Thus the NHIPS represented a departure from traditional means of estimating and reporting highway investment needs. Various simulation models were developed and applied to determine the relationships between alternative investment levels and anticipated physical, operational, and performance conditions and characteristics of the various highway systems.

The 1980 needs study continued the concept of performance-related investment evaluations. The Highway Performance Monitoring System (HPMS) provided the essential data for the evaluation of past and present programs and policies, which will serve as a basis for the assessment of proposed policies and program alternatives. The HPMS is a carefully designed coordinated data system, consisting of detailed data for a sample of sections and limited universe control data. The data base is also a source for various analytical models. The system is designed for continuous monitoring. Periodic updates from 1 to 5 yr are established for three categories of data.

The first category includes administrative items such as mileage by functional class, jurisdictional responsibility, etc., which are monitored on an annual basis. Second, there are data items that vary as a result of time and include such items as pavement condition, traffic, etc. For each of these items, update cycles are developed based on rate of change and the importance of the data item. The third category consists of physical changes, such as number of lanes, lane and shoulder widths, pavement improvements, etc., resulting from capital improvements, which are reported as they occur. Establishment of the basic sample data and a system for monitoring the magnitude of change allows HPMS to serve as a base for evaluating changes in highway element values over time and is the basis for measurement of highway performance. Further implementation of the system is underway.

CHAPTER TWO

A PROCEDURAL FRAMEWORK

INTRODUCTION

One purpose of a transportation needs study is to define the overall scope of the transportation problems that exist in a state. This provides a range of projects and guidelines from which programming decisions can be made. Thus estimating transportation needs that adequately and realistically reflect the limited financial resources available in the foreseeable future is but one element in an overall planning, programming, and design process. One of the most recent descriptions of this process appeared in *NCHRP Synthesis 48* (*6*). Figure 1 summarizes the major steps in that overall process. Of particular relevance to this synthesis are the steps noted with asterisks (see Fig. 1). The remainder of this report will expand on some of those steps and will supplement and update the information with a summary of recent experiences in dealing with those and related issues.

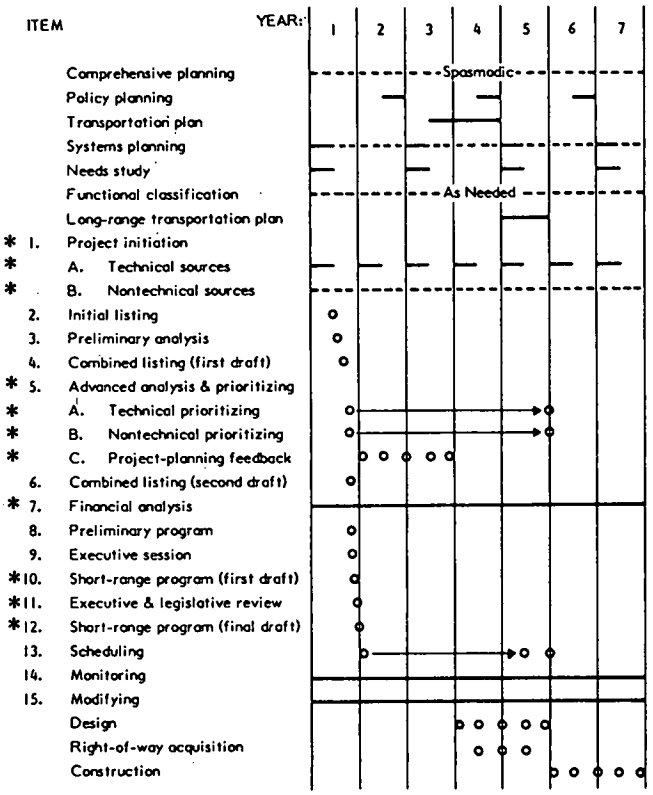

FIGURE 1 Planning, programming, and design process phasing (*6*). (The steps relevant to this synthesis are marked with asterisks.)

A GENERALIZED PROCEDURAL FRAMEWORK

Considerable thought and planning must precede the development of transportation needs estimates for each mode, and then those estimates must be considered within the constraints of limited financial resources. Current procedures used successfully by several states include certain key activities that appear to be basic to the task of developing these estimates. Figure 2 depicts a generalized procedural framework for all modes of travel. It should not be viewed as an "ideal" model to be followed, and the activities are not necessarily in order of priority or in the sequence that may be most appropriate for a particular set of circumstances. Further, it will no doubt be necessary to go through an iterative process, as activities will have to be repeated based on the results of actions completed at a later time.

The numbers for the procedures listed in Figure 2 and the order in which they are presented in the subsequent discussion are used for convenience and clarity in presenting the material. They are not intended to denote priorities or a specific order. The activities listed in Figure 2 are described in this chapter; references are cited to assist readers in obtaining more detailed guidance on available technical procedures. Specific examples of recent experiences of state highway and transportation departments and analyses performed by them are also included.

Several computer-based analytical procedures are described in the following material. The reader should not misinterpret the inclusion of such material to mean that computer-based procedures are essential in the analysis of transportation needs and related issues. Although there is some capability to transfer computer techniques from one state to another, it is usually necessary to adjust techniques to match the characteristics and circumstances of a state. Depending on the situation, less complicated (i.e., non-computer) procedures may be more appropriate.

The recording and documenting of all the subtleties and nuances that are part of this overall process are virtually impossible. The case studies described in the appendix are included as examples of actual experiences.

Estimate Future Funding For Each Mode

This is one of the most essential procedures in the development of needs estimates to fit constrained financial re-

sources. A realistic forecast must be made of a likely range of values of revenues from all current sources for each mode. The following factors should be considered:

1. Evaluation of all sources: (a) federal (based on current apportionments and commitments and likely future programs); (b) state (based on a forecast of revenues from current sources and at existing rates of taxation; and (c) local (when local funds are an essential part of a state/federal package).

2. Separate evaluation of sources for each mode; individual forecasts must be made to account for different time frames, different sources from each level of government, and different long-term commitments.

3. The time periods for which forecasts can be made will vary, depending on the circumstances within a state; however, the following categories may be realistic: (a) 1 to 5 yr; 5 to 10 yr; and 10 yr and beyond (this may be too speculative to be realistic, but circumstances may require it).

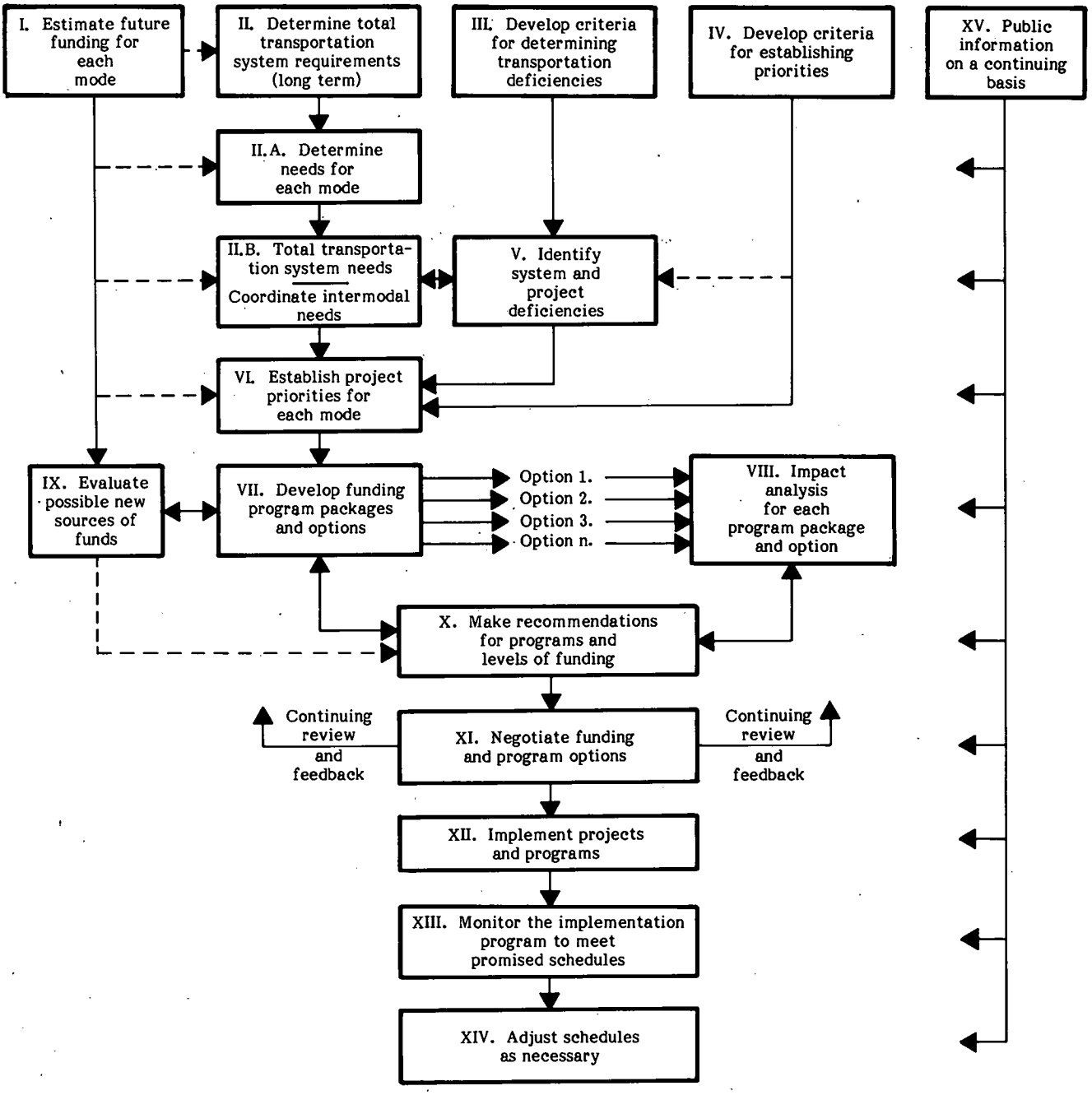

FIGURE 2 Generalized procedural framework for estimating transportation needs within constrained financial resources.

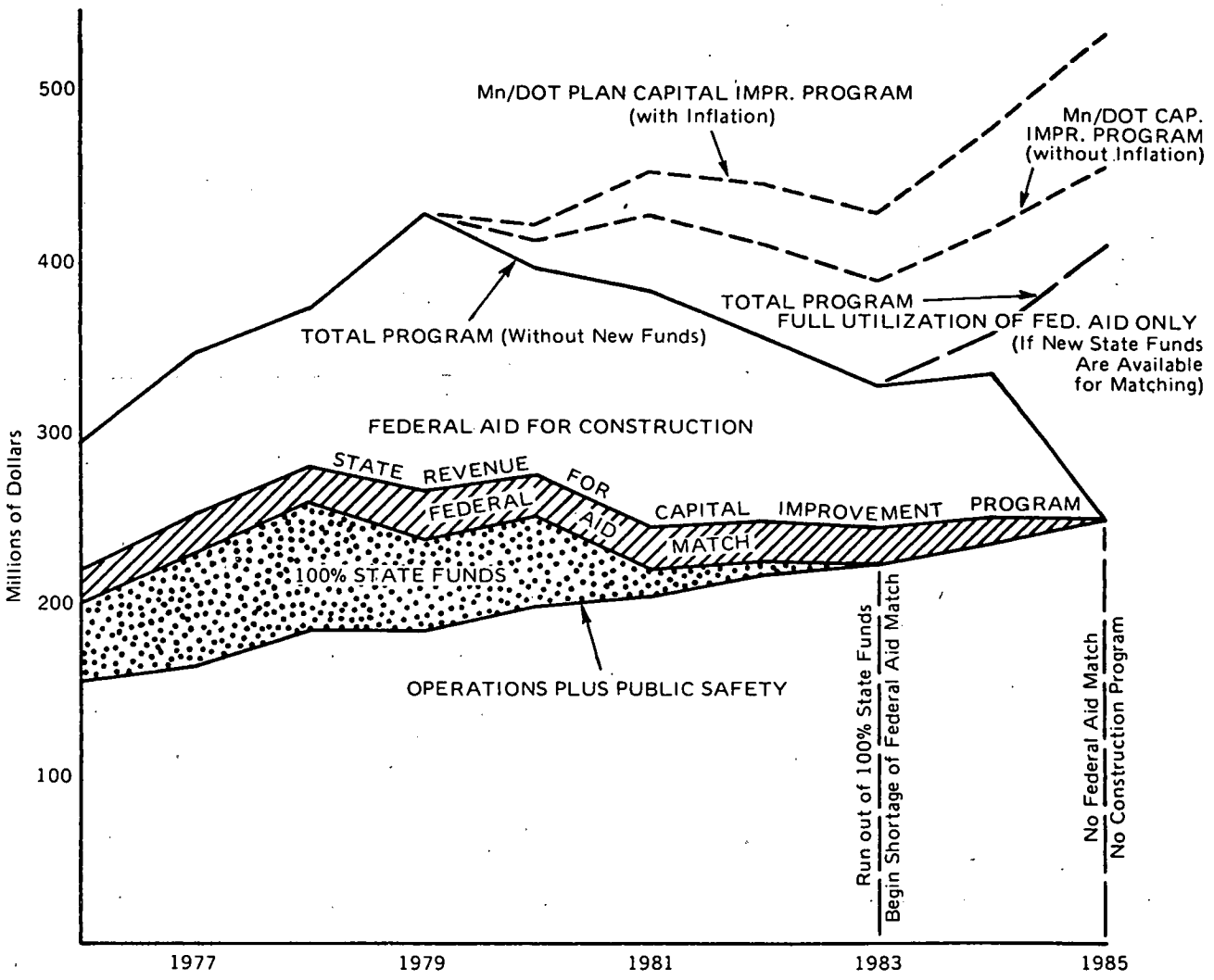

FIGURE 3 Historic and projected highway revenues and expenditures (Minnesota) (*8*).

Current Practice

Recent publications have summarized the procedures employed by several states in estimating future funds that will be available for highway programs. Some typical analyses (with appropriate references) follow. These summaries are not intended to be exhaustive but illustrate current practices in some states. Some procedures are based on the application of computer models, and others are based on relatively simple trend analyses. A state should use the procedures to which they are accustomed; a computerized procedure is not essential to this analysis.

Minnesota

Figure 3 illustrates a number of problems identified in the Minnesota State Transportation Plan of July 1, 1978 (*8*). Matching federal funds and continuing adequate routine maintenance of the state highway system are the highest priorities for state funding. Without additional state highway revenues, Minnesota must face the alternatives of either reducing routine maintenance levels or not matching all available federal aid by about 1985 in order to continue to fund necessary maintenance and other 100 percent state-funded programs.

Texas

Figure 4 shows a similar situation forecast by the Texas State Department of Highways and Public Transportation (*9, 10*). In 1976 the department projected available state revenues to the year 2000 at 1976 rates of taxation. The three conclusions drawn from that projection were:

1. By 1981, no construction funds would be available to build 100 percent state-financed projects.
2. By 1982, state funds would be insufficient to match any FHWA Urban Systems Funds.

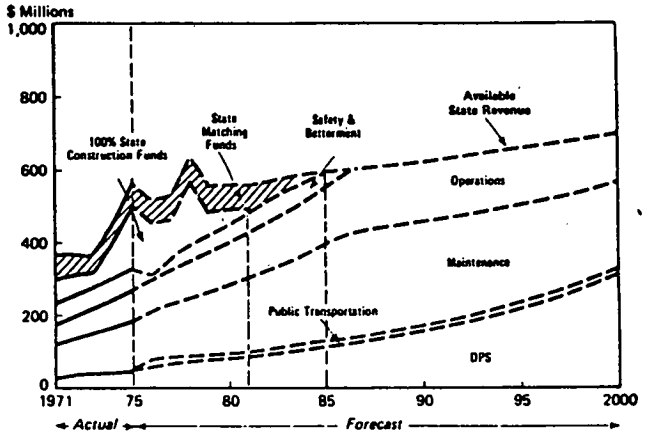

FIGURE 4 Application of available state revenue (Texas) (*6*).

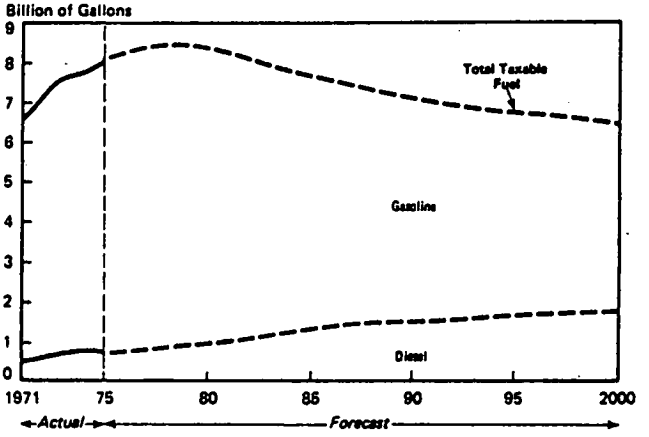

FIGURE 5 Taxable fuel consumption (Texas) (*10*).

3. By 1985, state funds would be insufficient to match *any* FHWA funds except as permitted by special general fund appropriations.

The Texas forecasts were developed using a computer tool called the highway funds forecasting model (HIFUND) (*10*). The application of this model included the projection of taxable fuel consumption as shown in Figure 5. As can be observed in this figure, this major source of revenue will begin to provide substantially reduced revenues after 1978–1980 because of the improved fuel efficiency of new automobile fleets being produced in accordance with the CAFE standards.

HIFUND is based on assumptions concerning the driving population; it projects revenues and then applies those revenues to the department's most basic expenditures. The amount of funding that would remain for construction of the existing backlog of projects and how that amount would change under different situations can then be indicated.

California

In the mid-1970s the California Department of Transportation recognized the need to develop a balanced future highway system that could be funded and controlled (*11*). A systems planning process was developed, which included the following key features:

- Identification of program funding constraints,
- Development of criteria for selecting and evaluating projects, and
- Control of the short-range program.

California developed a computerized procedure, called HIGHPLAN, to forecast revenues (Fig. 6). (HIGHPLAN

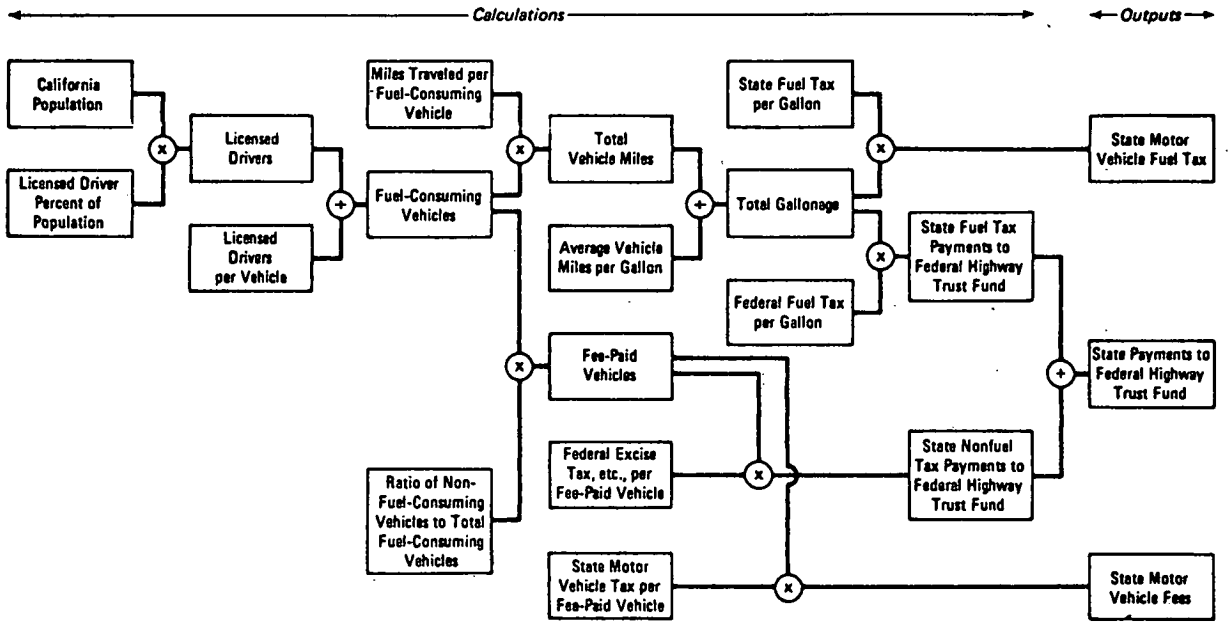

FIGURE 6 California HIGHPLAN model diagram (*12*).

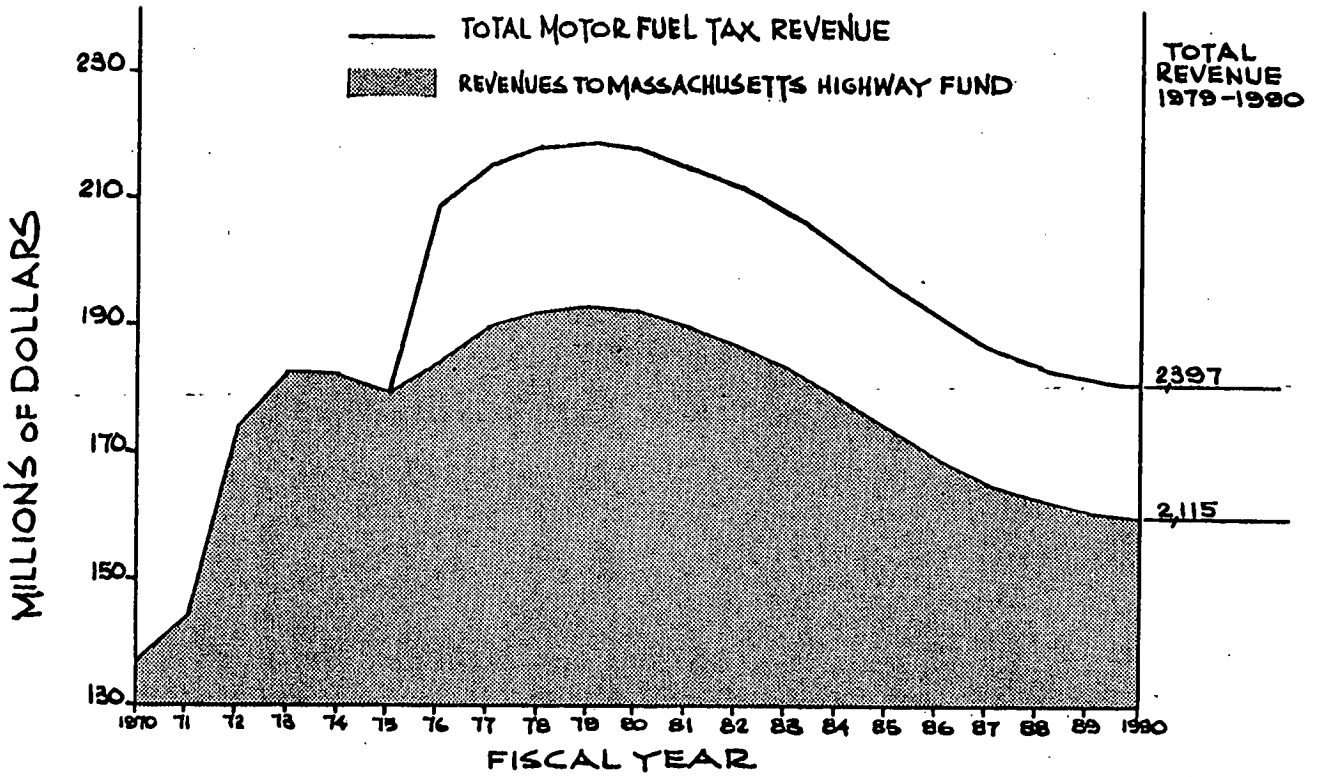

FIGURE 7 Motor fuel tax revenues (Massachusetts) (*13*).

has recently been replaced by a second-generation model called FINPLAN.) The model outputs were adjusted to reflect both the rate of return from the Federal Highway Trust Fund and the trend in the construction cost index. These forecasts were then used in the analysis of the highway system deficiencies in developing a system-balanced level of service plan.

Massachusetts

In Massachusetts motor fuel taxes are a major source of funds for highway programs, with substantial supplement from a variety of motor vehicle fees and taxes (*13*). Figure 7 shows the projections of motor fuel revenues anticipated to the year 1990, based primarily on the federal standards for automobile fuel economy. Reductions in travel as a result of substantial increases in the price of gasoline were not considered. The projections included the assumptions that the rates of increase in travel (as measured by vehicle miles of travel) and in vehicle registrations would be lower than past trends. The assumption of these changes resulted in a forecast of revenues that would decline from a yearly total of $275 million in 1979 to $247 million in 1990, a decrease of 10.2 percent. This is shown by the curve in Figure 8, which also shows the gap between anticipated revenues and anticipated program requirements for that 12-yr period.

Additional Technical Procedures

The preceding summaries briefly highlight techniques that have been used and factors that have been considered by some states in estimating future highway revenues. Following are additional references that may also provide guidance in carrying out this important step.

- *NCHRP Report 199* (*5*) describes the application of the highway user revenue model (HURM). This is a computer-based procedure for forecasting three basic types of highway user revenues: (a) motor vehicle registration fees, (b) motor vehicle fuel tax collections, and (c) motor vehicle excise tax collections. HURM was developed and calibrated for Maryland. It is not necessarily readily applicable to other states without additional adjustments.
- *Transportation Research Record 698* contains several relevant papers (*14, 15*). The one most pertinent to this discussion is a study of the feasibility of multimodal transportation trust funds on the state level (*15*). Although this paper does not focus on procedures for revenue forecasts, it does present the results of a nationwide survey to identify options for dealing with the problems created by reductions in revenues from motor fuel taxes combined with rapidly increasing inflation in transportation construction, operation, and maintenance. Based on the 36 responses received, the concept of a multimodal transportation trust fund at the state level is viewed favorably. However, the problems that might be raised by such a

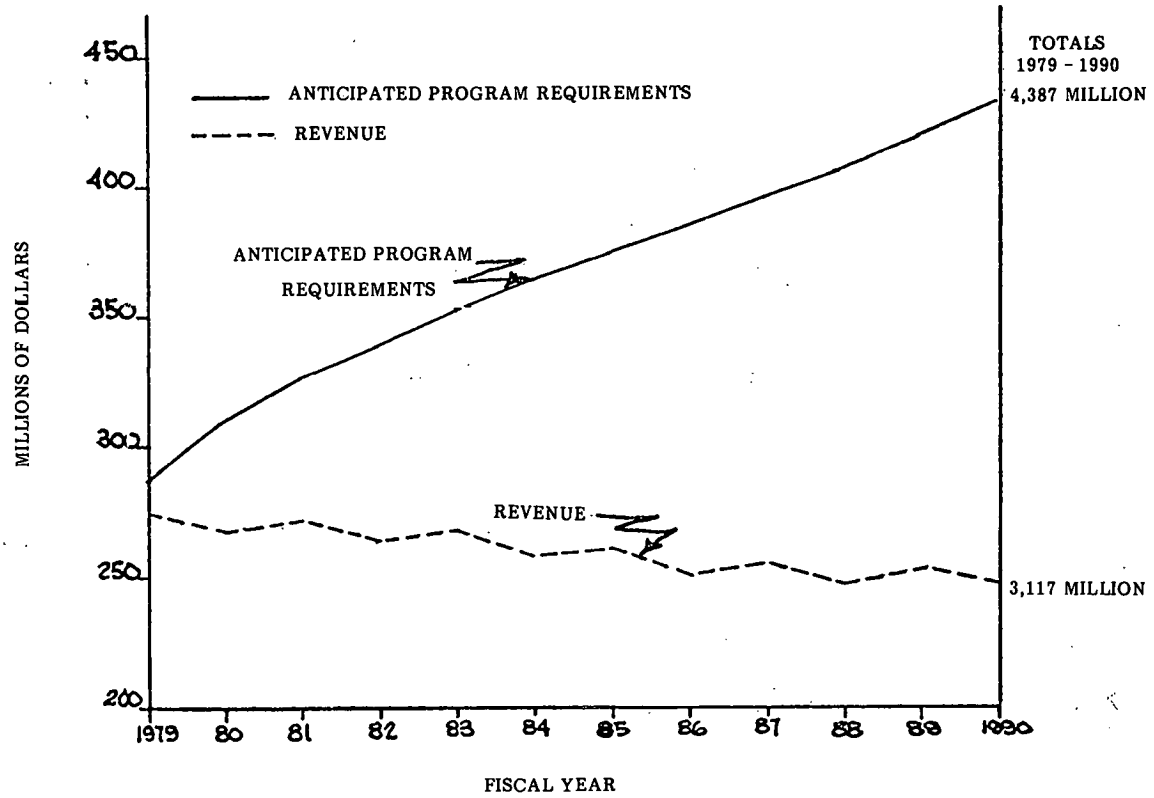

FIGURE 8 Forecast of highway revenue and expenditures in Massachusetts (*13*).

proposal and the political battles that would occur make its enactment in most states highly unlikely. The respondents expressed strong support for the continuation of the Federal Highway Trust Fund, and gave a strong mandate to the need for a stable, dependable source of federal mass transportation assistance.

- *NCHRP Synthesis 62* (*7*) provides a summary of all likely funding sources for transportation programs. It contains a description of the important factors to be considered in forecasting future revenues, such as revenue bases not responsive to inflation, a relative slowdown in motor fuel consumption, soaring costs of all aspects of transportation programs, and a conversion to motor fuels not currently included in transportation funding programs.
- A report by the AASHTO Subcommittee on Financial Management (*16*) provides a national state-by-state summary of current sources of revenues from motor fuels (gasoline, diesel, gasohol, etc.). It also describes taxing methods on alternative fuels that are being considered by the states and difficulties anticipated in obtaining approval for new revenue sources from alternative fuels.

Determine Total Transportation System Requirements Over A Long-Term Planning Period

To obtain information for this synthesis, transportation officials in 16 states were contacted during the summer and fall of 1979. A consistent pattern of responses indicated that a project-by-project approach in identifying transportation needs was not an adequate way to initiate the development of the most cost-effective transportation programs, regardless of the mode being considered. The consensus was that transportation planners must evaluate the needs of the entire transportation system in order to:

- Develop a "big picture" look at all needs to provide an overall basis for making tradeoffs among the highest-priority needs.
- Identify opportunities for reducing design standards and policies to better fit available funding (for example, where conditions permit, selecting a new arterial street design instead of an expressway design).
- Identify modal tradeoffs within *specific* corridors where such tradeoffs can be made (it should be noted that there are usually limited opportunities for tradeoffs *between* different modes.) One example could be the selection of express buses using exclusive high-occupancy vehicle lanes—which could also accommodate carpools—during peak hours as an alternative to building a new fixed rail facility; another example could be the development of water transportation options as an alternative to rail improvements within the same corridor).
- Identify options that might provide for low-cost capital improvements as alternatives to the construction of more expensive, new projects (this would include the design and implementation of TSM improvements instead

of the construction or reconstruction of a high-cost highway facility).

• Identify maintenance needs as a high priority of the overall transportation program. In addition to construction and operating costs, maintenance and physical replacement costs must be considered in a comprehensive analysis of needs. For example, a bridge that physically deteriorates must be physically replaced; it cannot be replaced by a TSM project.

Each state has developed its own procedures for estimating transportation needs. Many of the references cited previously provide descriptions of the methods used by some states in determining total transportation system needs.

An outline of what appear to be the major steps in establishing total system needs is presented below. The case studies described in the appendix present information on the procedures used in several selected states and examples of the application of these procedures.

A. General

1. Establish long-range system objectives for each mode as well as the intermodal requirements for the movement of people and goods. This analysis should be based on traditional system planning objectives, quality of service desired, safety, and mobility considerations.
2. Provide for system continuity and balance.
3. Establish minimum tolerable standards.
4. Develop subsystem plans that are more manageable.
5. Determine the data and information needed to evaluate current existing transportation systems. Data should be consistent and easily obtained from year to year to avoid the need for costly new data collection efforts to obtain information needed only once.

B. For Highways

1. Identify the minimum program that *must* be funded. This will probably include: (a) capital replacement costs for physically deteriorated roads and bridges; (b) completion of the interstate system (because of funding commitments); (c) the minimum program needed for maintenance; (d) operational improvements (TSM); and (e) reconstruction to improve the existing system, such as resurfacing (other than maintenance), safety projects based on minimum safety criteria, and capacity increases considered essential.
2. Identify major new construction projects on new location, considering (a) the minimum number necessary to accommodate new growth, and (b) other necessary projects, such as those needed to provide access to transit facilities.

C. For Urban Transit (Bus, Rail, and Commuter Rail)

1. Upgrade the existing system, including (a) new equipment, (b) station improvement, and (c) track and equipment maintenance.
2. Determine operating budgets necessary to maintain existing levels of service.
3. Provide expansion of system and service as required and within available and forecasted budgets.

D. For Intercity Modes (Air, Rail, and Water)

1. Upgrade the existing system.
2. Determine operating budgets necessary to maintain existing levels of service.
3. Provide expansion of system and service as required and within available and forecasted budgets.

One final note is worth consideration. The state of the art is such that it is difficult, if not impossible, to consider multimodal system needs as a single comprehensive package. At best, a state might be able to consider multimodal corridor needs for a large metropolitan area (such as rail versus express bus service in high-density corridors) or for the intercity movement of commodities (where a tradeoff might be possible between truck or rail or water). This topic was discussed and reported in the Proceedings of the Second Conference on Statewide Transportation Planning and Programming, which was held at Airlie House, Virginia, in April 1979 (*17*). The generalized procedural framework shown in Figure 2 includes two activities that relate to this matter: IIA, "Determine needs for each mode"; and IIB, "Total transportation system needs—Coordinate intermodal needs."

Develop Criteria For Determining Transportation Deficiencies (*2–4, 6*)

An obvious step in identifying transportation needs is establishing criteria for determining those transportation facilities and services that are acceptable or not acceptable. Each state has developed its own criteria, usually based on the following elements:

- Operation characteristics;
- Design standards (which may have to be downgraded in order to maintain minimum acceptable overall system-wide performance and safety standards);
- Performance standards; and
- Safety standards.

An important consideration in developing criteria for judging the adequacy of transportation facilities and services is that minimum standards may have to be downgraded more than is desirable (but still within minimum safety standards), as indicated in the following examples.

Tennessee

In the development of transportation improvement packages to fit alternative funding situations, the Tennessee Department of Transportation established three levels of design standards for highway programs (*18*).

1. The Desirable System was based on providing a supplemental freeway system for a majority of the 1625 miles (2600 km) of principal arterials; the remainder of the arterials would be constructed to current state highway standards and the collectors constructed to current state secondary standards. It was decided that this option was too expensive; thus the following two options for design standards, which are less rigid, were developed.
2. The AASHTO System was also based on current state design standards, which were based on AASHTO standards, but no supplemental freeway system was proposed. Collectors and local roads and streets would also be constructed and maintained to existing standards. This system was also considered too expensive to be funded by anticipated revenues; thus a third option was developed.
3. The Tolerable System differed from the first two systems in that arterials would be improved only to the extent of being functionally adequate to accommodate an average speed of 55 mph (88 km/h) throughout the state (a reduction in AASHTO standards). Collectors would be improved to current rural standards (also a reduction in current standards), and local streets and roads would be constructed and maintained to meet existing standards.

Even though a minimum funding program package was developed for the Tolerable System, adequate funds were still not available to fully finance this program at current levels of taxation. Thus the choices appeared to be (a) reduce standards further or (b) increase revenues. At the time this report was prepared, this problem had not yet been resolved in Tennessee.

South Dakota

South Dakota offers another excellent example of the need to evaluate alternative design standards in establishing criteria for determining transportation deficiencies. The South Dakota Department of Transportation established four sets of design criteria for evaluating the deficiencies of the state's highway system and for developing programs and funding alternatives to satisfy needs (*11*).

1. Current design standards (ultimate improvement).
2. Downscoped design standards, based on designs that provide for more rolling grade lines, not surfacing the full shoulder width on previously graded projects, steepening the shoulder slopes, constructing narrower shoulders on new projects, narrowing the right-of-way, and doing shoulder widening and resurfacing instead of complete reconstruction.
3. Moderate improvements, intended to improve the load-carrying ability of a highway and extend the service life of the surface for 17 to 20 yr without improving the general geometrics (also included in this category is the cost for improving structures in poor condition).
4. Spartan improvements, intended to maintain the status quo of a facility by extending the service life of the surface 8 to 12 yr without improving the general geometrics (this category also includes the cost of rebuilding structures in poor condition and those with narrow driving lanes).

The application of these four sets of standards to a typical highway project is shown in Figure 9. By means of this evaluation, the state found that even a gas tax increase of $0.02 per gallon ($0.05 per liter) every other year for the next 20 yr would not produce enough funds to consider improvements at a level greater than the downscoped design standards.

Additional Criteria

The technical procedures used to evaluate pavement and structural deficiencies vary from state to state. Most states have developed and used several systematic procedures. The earliest and simplest procedure was called a sufficiency rating.

Some states have expanded upon these techniques and have developed more comprehensive procedures. For example, the Wisconsin Department of Transportation uses a pavement serviceability index, which is described in the appendix.

Tennessee has developed the Tennessee roadway information system (TRIMS). This coordinated computerized data system contains information on geometrics, traffic, surface conditions, accidents, bridges, grade crossings, and other roadway characteristics, which is used in setting project priorities.

The Utah Department of Transportation has also developed a systematic procedure for determining the condition of roadway pavements. A pavement evaluation analysis is made by taking four measurements:

1. Serviceability (the serviceability rating of a pavement surface is determined by taking field measurements and computing a present serviceability index);
2. Distress ratings;
3. Structural adequacy; and
4. Skid resistance.

Pavement evaluation data are then analyzed, and program priorities are established based on those analyses.

Develop Criteria For Establishing Priorities (*2–4, 6*)

Each state has established its own priorities for spending on transportation improvements, but the criteria used to determine these priorities may have to be reevaluated. This is true for all modes of travel.

During the past 2 decades, two principal criteria have

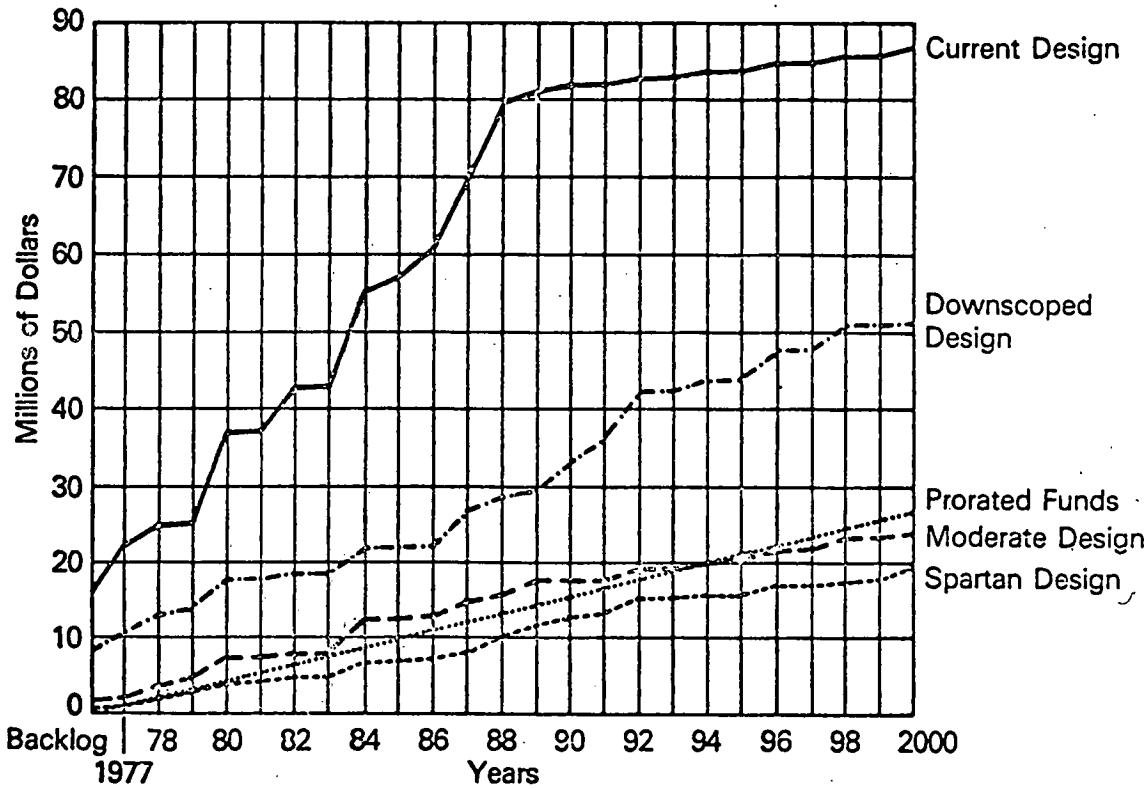

FIGURE 9 US-14 route analysis (South Dakota) (*11*).

been used to set funding priorities for highway programs: (a) matching all available federal funds, and (b) maintaining existing bridges and highways. Funding decisions have also been based on other criteria, such as economic development, the creation of employment opportunities, and service to new land uses. Although in many states the first two criteria have had the greatest impact on determining funding priorities, the current financial constraints experienced by the states have forced serious reconsideration of these issues.

As previously mentioned, some states will no longer be able to match all federal funds in the foreseeable future unless they make major sacrifices in maintenance programs or unless substantial increases in state funds are forthcoming. Greater emphasis is being placed on increased maintenance, low-capital improvements (TSM) of existing facilities, and public transportation as alternatives to major new highway improvements.

State governments are becoming increasingly involved in the planning, construction, and operation of public transportation facilities for urban, interurban, and interstate facilities. Thus transportation program funding packages are no longer limited to single mode options in many states. Governors and state legislatures are now considering all modes in integrated packages of funding requirements. This means, then, that consideration must be given to criteria other than those that have been considered for highways alone, including:

- Societal needs to provide mobility to all sectors of the economy;
- Energy conservation and contingency strategies to maintain mobility during potential energy crises; and
- The coordination of modes to provide complementary services and facilities and to ensure cost-effective means of moving people and goods.

Identify System and Project Deficiencies (*2–4, 6*)

This activity provides a logical link between the four activities described above. The determination of transportation needs according to various physical, social, environmental, and economic criteria will result in a list of system and project deficiencies. That list will no doubt substantially exceed the available financial resources in most cases. Thus it is essential to establish project priorities.

Establish Project Priorities For Each Mode (*2–4, 6*)

Several categories of projects are usually considered in establishing project priorities:

- Committed projects that are high-priority items carried over from previous years. (An important consideration at this stage is whether or not projects that have been

active for a long time still have a high priority. The priority of "committed" projects should be evaluated frequently.)

- Physical replacement projects that may have been recently identified.
- Federally funded projects requiring local/state match.
- Minimum maintenance requirements.
- Minimum new projects or services to serve land-use changes, population growth, and needs of commerce and industry (including reconstruction of existing facilities and new construction or new services).
- Remainder of projects (depending on the funds that are available), which could include additional federally funded projects, maintenance, and other new projects using 100 percent state funds.

A number of analytical procedures have been developed and applied in various states to assist in the development of project priorities. Most of these procedures have been utilized for highway programs. The TRB and NCHRP publications previously cited in this chapter contain relevant papers on this subject, some of which are summarized in the following sections.

Application of the Highway Investment Analysis Package

The highway investment analysis package (HIAP) is a computerized cost-benefit and cost-effectiveness model developed by the Federal Highway Administration to aid state, regional, and local governments in making the best use of limited highway funds (*19*). The package has two basic modules:

1. Project evaluation—uses microeconomic theory to analyze alternative improvements to individual roadway sections or limited networks of roadway sections.
2. Program development—uses the aggregate measures calculated for project alternatives at all sites to develop candidate investment programs for as many as four time periods.

Batchelder et al. (*19*) describe an application of HIAP by the Wisconsin Department of Transportation and a team of consultants.

Determination of Priorities for a Transit System

The Urban Mass Transportation Administration (UMTA) has recently established a policy for the incremental development of fixed-guideway transit systems (*20*). This policy necessitates the evaluation of system components and the subsequent assignment of priorities to system components.

The Metropolitan Atlanta Rapid Transit Authority undertook a comparative analysis study to determine the most appropriate order of construction for its "referendum" rail system. The referendum system, excluding that portion currently under construction, was divided into 13 operational segments (11 rail and 2 busway). Analytical information was compiled for each segment, including expected patronage, estimated construction and operating costs, annual revenue, travel time, and various nonquantifiable data. Three criteria were employed in the evaluation of segments: cost efficiency, travel utility, and an index representing nonquantifiable factors. The study was performed in a series of iterative analyses based on sequential decisions. The following conclusions were made: (a) The concept of iterative analysis provides a reasonable method for determination of system extension priorities. (b) The analyses were sensitive to differences among segments. (c) Wide variations of effectiveness were found among segments. (d) The incremental development policy may adversely affect the ability of local areas to obtain local support for mass transit plans.

Miscellaneous Procedures

NCHRP Report 179 (*4*) identifies 20 techniques that were examined for their applicability to the evaluation of multimodal transportation plans and programs. Most of these techniques have been applied in various states, and the appropriate references are included in the report.

NCHRP Report 199 (*5*) presents a detailed description of one of the techniques that was judged worthy of more complete evaluation. The priority programming procedure (PPS) was developed by the Ontario Ministry of Transportation and Communications to assign priorities to highway projects. The PPS computer model was installed and tested by the Maryland DOT, and a user's guide is included in the NCHRP report. However, the application of the PPS model to another state would require considerable effort.

The several case studies presented in the appendix provide information on procedures that do not necessarily depend upon computer models.

Develop Funding Program Packages and Options

This activity is the point at which all the previous work must be brought together into a coherent and logical set of recommendations. It is the stage where "needs" estimates are packaged to fit the constrained financial resources likely to be available.

The case studies described in the appendix provide a summary of the approaches used in several states and illustrate the necessity of evaluating both funding options and project or program options. The development of program packages and options also provides an opportunity to make tradeoffs based on the criteria established in activities III and IV (see Fig. 2).

This activity represents a major change in approach as compared with procedures used previously in many states. It recognizes that changes in priorities may have to be made and certain standards may have to be lowered in order to continue to provide minimum levels of transporta-

tion services. This procedure also provides decision makers with the opportunity to make rational judgments on the basis of facts that may not have been available previously.

In those states where alternative program packages have been developed, the various funding levels have been established in a variety of ways. Following are some of the techniques used in this process:

- Continuation of existing funding levels (which would result in a decline in the real-dollar value caused by inflation).
- An annual increase in funds based on current rates of inflation (this could represent the largest kind of increase).
- A value based on current levels of funding plus some other percentage increase (i.e., other than inflation alone).
- A fixed yearly figure based on the sum of (a) state funds needed to match federal funds plus (b) state funds needed for high-priority maintenance projects plus (c) state funding of other high-priority projects.
- An amount established through negotiations between the executive and legislative branches of government and determined by current budgetary conditions.

The next step in the process is to develop several "packages" of programs that can be implemented, each based upon a given funding level. The following simple table illustrates how this might be accomplished:

	Projects (or Programs) to be Implemented for *n* Yr at that Funding Level			Projects (or Programs) That Cannot be Implemented During That Time Period		
Funding Level (for *n* yr)	Maint.	Operations	New Projects	Maint.	Operations	New Projects
1. $X	---	---	---	xxx	xxx	xxx
2. $Y	---	---	---	xxx	xxx	xxx
3. $Z	---	---	---	xxx	xxx	xxx

This type of table could be developed for several categories, including (but obviously not limited to) geographic area, time periods, and different modes. An essential part of the information to be presented is a clear indication of the choices that must be made at each funding level. If $X represents the lowest level and $Z is the highest, the details of the increasing magnitude of the program should be stated clearly. Decision makers should understand which programs and projects *cannot be implemented* at the lower funding levels for a given time period.

The goal at this stage is to provide the information needed to make the appropriate tradeoffs. The impact analyses (see the following section) will also provide information essential to making those tradeoffs. The case studies (see appendix), which present several examples of approaches used by various states, serve to demonstrate the importance of this activity.

Analyze The Impact of Each Program Package and Option

A thorough and proper evaluation of the advantages and disadvantages of each program package established in the preceding activity should include, where possible, an impact analysis for each option. The impacts to be evaluated include the following (not listed in order of priority):

- Energy impacts. In recent years, this has become an essential element in determining how limited transportation funds should be expended for all modes.
- Economic impacts. This includes not only the short-term benefits of providing jobs during construction but also the longer-term impacts on all aspects of the economy of a state.
- Transportation service impacts. There may be a more urgent need for rebuilding and maintaining critical links in the transportation system than for building or expanding new facilities or services. This tradeoff could play a key role in determining how limited funds should be used.
- Community and social impacts. Either strong opposition or strong support for certain projects may be determining factors in deciding how limited funds should be spent. These factors can often override what appear to be strong "technical" reasons for particular projects (such as the need to increase highway capacity in a particular corridor).
- Geographic impacts. The need to equitably distribute available state (and federal) transportation tax revenues is a key concern. It would be difficult (and often impossible) to allocate funds strictly on the basis of, for example, population distribution in a state each year. However, it is essential that an equitable distribution of funds be made over a period of time.
- Land-use impacts. The obvious relation between land use and transportation must be considered in making all transportation investment decisions.
- Environmental impacts. Each state has established its own procedures for evaluating environmental impacts in response to either the National Environmental Policy Act or state environmental laws, or both.

It should be emphasized that as many impacts as possible be evaluated and included in the evaluation of program packages.

Evaluate Possible New Sources of Funds

At the time this report was prepared, many states were facing the problem of having insufficient funds for transportation needs. Transportation needs are defined as the minimum requirements to maintain and operate existing transportation facilities and services and to build the new facilities neecssary to continue to provide the most cost-effective transportation system possible.

In July 1979 the Highway Users Federation for Safety and Mobility identified recent trends in state highway program revenues (*21*). The report outlined new ap-

proaches being used or considered by the states to raise funds to meet growing highway needs. It was shown that the states had relatively little success in obtaining increased funds for highway programs during the previous 2 yr, even though motor fuel revenues had been declining (due to the CAFE standards and reduced fuel consumption resulting from conservation) and inflation had substantially reduced the value of the dollar.

A September 1979 report by the AASHTO Administrative Subcommittee on Financial Management (*16*) assessed the possible impact of alternative fuels on highway revenues. Information was collected by means of a questionnaire that was distributed to each state. The following conclusion was reached:

> No new funding mechanisms for alternative fuels are apparent. Taxes on alternate fuels are being levied in the traditional manner. There is a tendency toward reducing taxes on alternative fuels which may encourage their use, but in the process this is reducing highway revenues. At the present time it seems that an energy problem will either cost more money or reduce revenues or both.

NCHRP Synthesis 62 (*7*) presents the most recent study of the issues involved in the use of state resources for financing transportation programs, reporting the following conclusions:

> In recent years, the states have faced a crisis in the provision of transportation facilities and services. Some of the reasons for this crisis are:
>
> A revenue base that is not responsive to inflation.
> A relative slowdown in motor fuel consumption, the principal present source of revenue.
> Soaring costs.
> Greater sensitivity to social and political pressures.
> Increasing demands for transportation facilities and services. . . .
>
> An in-depth review of both user financing and general taxation has turned up no hidden revenue fountain to rescue states from difficulties in providing for transportation needs. On the positive side, no flaws were revealed in current methods of financing of such nature and magnitude that appropriate revenue levels cannot be achieved. Revenue issues pertain mainly to the distribution of the burden. What appears to be needed is an institutional framework that will facilitate timely adjustments in the revenue structure.

The three reports cited above are consistent in concluding that (a) there are definite problems to be faced in providing additional revenues for transportation programs, (b) there are no easy answers or solutions to those problems, and (c) the situation is not hopeless, as the potential for obtaining additional revenues is substantial if careful study and analysis are used to clearly document the need.

However, additional revenues are not easily obtained. During 1978–1979, 11 states increased gasoline taxes by $0.01 (five states), $0.02 (five states), or $0.03 (one state); 15 states attempted to increase fuel taxes and failed. Seventeen states attempted but failed to obtain approval for a variable gasoline tax (percentage-based); four of these states attempted and failed twice. At the time this report was prepared, only Washington and New Mexico had been successful in approving a percentage motor fuel tax.

The case studies presented in the appendix include descriptions of some approaches that have been used by some states in attempting to raise additional revenues. Procedures used in several other states are described below.

The Texas Department of Highways and Public Transportation developed a unique approach to providing the highway funds necessary to meet minimum needs (*9, 11*). A number of alternative funding sources were analyzed; the program ultimately approved by the Texas legislature in April 1977 met the objectives of adequacy, continuity, and responsiveness to inflation. The approved program provided a base level of $700 million for fiscal year 1977–1978 and $750 million for each fiscal year thereafter. This base level is multiplied by a cost index (minus dedicated revenue) that is the weighted combined cost of highway operations, maintenance, and construction for the appropriate year compared to the costs of those items used for the fiscal year beginning September 1, 1979. The cost index is established before each fiscal year by a committee consisting of the governor, the lieutenant governor, and the state comptroller of public accounts. The guaranteed fixed sum of money based on the inflation adjustment factor includes a combination of dedicated highway-user revenue plus additional funds from the general fund. When combined with the additional general revenues, the new legislation provided $528 million more than would have otherwise been available during the first 2 yr.

In Washington, the percentage tax fluctuates with the average retail price of motor fuels; this policy was intended to insulate the state from some of the inflationary problems being experienced throughout the country. As of July 1, 1979, the tax was raised to $0.12 per gallon ($0.32 per liter), which is the maximum level permitted in the state without further legislative action and the highest motor fuel tax in the nation.

In 1979 Massachusetts attempted to establish a variable tax rate on motor fuels; the proposal was defeated. (More details are included in the case study in the appendix.)

The AASHTO report (*16*) contains a comprehensive summary of current taxes on motor fuels for the 46 states that responded to the survey questionnaire. The fuels for which taxes were reported included regular, unleaded, and premium gasoline; diesel; gasohol; methanol; and others (jet, aviation, LPG, CNG, propane, and hydrogen). The types and amounts of taxes reported included tax per gallon, sales tax (when used), and other taxes. Six of the reporting states indicated that they levy a sales tax on motor fuels.

Make Recommendations for Programs and Levels of Funding

At the recommendations stage, the analyses of transportation needs and required revenues must be evaluated and a final set of recommendations made to the governor and the legislature. The sequence of activities will naturally vary from state to state.

Documenting the reasons both for making specific recommendations and for rejecting certain options is essential. It is also essential to document the impact of taking certain actions or not taking those actions.

Negotiate Funding and Program Options

The critical stage in the development of transportation needs estimates occurs when funding and program options must be decided. At this stage, the essential details are worked out, and the final decisions are made on the programs to be implemented based upon specific funding levels. For each mode of transportation a decision must be made in selecting one of two basic options:

- A fixed or reduced level of funding, based on current revenue sources and rates of taxation. Transportation programs would have to be reduced or cut back to fit that level of funding, assuming it was inadequate due to inflation and reduced revenues (e.g., caused by reductions in gasoline consumption).
- A particular dollar value established for projects, based on project priorities. In this case, additional sources of revenues would be needed.

If the first option is selected, the analysis described previously will provide the information needed to assist in establishing priorities and in deciding which projects to drop. The negotiations needed in this case will be with state and local agencies having competing priorities and interests; the key to the negotiation process will be discussions with the legislative branch of the state government.

If the second option is selected, the major negotiations will likely be between the governor and the key members of the legislature who are responsible for recommending new funding sources. The amount of new funding that is approved (if it is approved) may bear no relationship to the amount recommended during the technical analysis. For example, if the program package selected for implementation requires an additional $50 million, but there is only $30 million available from a surplus general revenue account (the only possible additional revenue), then the $30 million will have to be acceptable. The entire study process would have been at least partially successful, because documentation would have been required in any case to justify additional funding.

Obviously, short-term solutions to long-term funding problems are not the best solutions; they may simply delay the more painful decision of raising taxes to some later date. The essential point is that the transportation analysis must be comprehensive and thoroughly documented to provide the facts necessary to allow for a view of the problem that is longer range than simply a 1- or 2-yr estimate of project and funding needs.

Implement Projects and Programs

After agreement has been reached by all the parties concerned, the next activity is to implement the projects and programs.

Monitor the Implementation Program To Meet Promised Schedules

Some states have implemented comprehensive management systems to monitor the flow of work from the planning stage through the implementation stage. However, other states have not felt the need to implement such management control schemes.

It is essential that the credibility of the process described above be maintained, especially if an argument has been made (and won) that new funds are needed to implement programs. Every effort must be made to monitor program schedules on a continuing basis. If this is not done (and done successfully), the next time a transportation agency tries to argue the same case, the erosion of credibility will definitely inhibit the agency's ability to convince the governor, the legislature, or the public of the need for transportation programs and funding.

Adjust Schedules as Necessary

As part of activity XIII (see Fig. 2), a formal procedure should be established to adjust schedules as necessary and to inform appropriate individuals and agencies of such adjustments. There are numerous legitimate reasons for delays. However, there will be a reduction in credibility if communication does not continue during the implementation stages.

Public Information on a Continuing Basis

There is a need for continuing and comprehensive public information on the problems and issues covered in this report. The documentation of "needs" and funding problems should be made available throughout the entire state. It is essential to keep all relevant state agencies and the state legislature fully informed on a continuing basis. It is also useful and sometimes essential to involve the private sector, the news media, and key interest groups and to keep them informed on the issues.

In distributing the results of technical analyses throughout the state and to as many groups and individuals as possible, it is important to provide sources of contact in readily accessible locations who will be responsive to questions, comments, and suggestions. The technical material must be written in simple and concise language and must provide the information necessary to determine the impact on each affected person and area of the state.

CHAPTER THREE

CONCLUSIONS

GENERAL CONCLUSIONS

In one form or another transportation needs studies are conducted by all states. Many states appear satisfied with their procedures and results; others do not. Even within a particular state, there is often disagreement among state officials concerning the most appropriate techniques for and uses of needs studies.

There are no typical needs studies or typical uses of a needs study. However, there are many similarities in the kinds of studies used throughout the country. Some procedures are quite sophisticated and make use of continuing updates of computerized data and various computerized models for forecasting and analysis. Other techniques are relatively simple, using minimum amounts of consistently collected data or models. Most studies make use of a combination of these two extremes.

Transportation needs studies can be used to accomplish numerous objectives, including:

- Providing the technical data needed to determine transportation investment levels for capital, maintenance, and operating needs;
- Justifying the initiation of new projects;
- Justifying the expenditure of funds at desired program levels;
- Identifying and evaluating the relationship between transportation, land use (land-use plans may have to be reevaluated in the context of lowered expectations for future transportation programs), and various interrelated programs;
- Identifying projects that qualify for reconstruction instead of routine maintenance;
- Fulfilling state or federal legislative requirements; and
- Providing a basis for making tradeoffs between programs and program funding levels.

This synthesis presents information on how transportation needs studies are used as the basis for developing programs within constrained financial resources. Included in the discussion is consideration of the manner in which tradeoffs are made between various capital, maintenance, and operating alternatives. Frequently, there are also alternatives within the categories of capital, maintenance, and operating needs. Thus a matrix of tradeoffs can be written as shown in Table 1.

In the simple example of Table 1, the matrix includes 27 funding options from which to select in developing a program (i.e., nine options within each of three total funding levels). Depending on various circumstances within a state, there may be fewer or more options available. One of the critical variables in this example is the manner in which available funds may be earmarked for particular modes or for particular project categories within a mode. Earmarked federal funds obviously have a significant impact in this area. In many states, funds (or sources of funds) are earmarked specifically for capital and maintenance programs; thus the number of options will be restricted.

The administrators of state transportation programs are concerned that traditional sources of revenues for transportation programs at current rates of taxation are not producing the revenues necessary to meet minimum needs in most states. Thus a decision must be made either (a) to reduce the magnitude of new programs, maintenance, and opera-

TABLE 1
TRADEOFF MATRIX

	Total Funding Levels		
Needs	$X	$Y	$Z
1. Capital			
Option 1	X^1	Y^1	Z^1
Option 2	X^2	Y^2	Z^2
Option 3	X^3	Y^3	Z^3
2. Maintenance			
Option 1	X^4	Y^4	Z^4
Option 2	X^5	Y^5	Z^5
Option 3	X^6	Y^6	Z^6
3. Operating			
Option 1	X^7	Y^7	Z^7
Option 2	X^8	Y^8	Z^8
Option 3	X^9	Y^9	Z^9

tions to fit the budgets available; or (b) to provide the documentation needed to persuade the governor, the legislature, and the citizens of the state that additional funds are necessary.

The current shortages of funds are not necessarily caused by the desire to build large numbers of new projects or to increase maintenance efforts substantially. The costs of construction, maintenance, and operations have increased faster than revenues because of rapid advances in the inflation rate. Thus simply maintaining previous levels of services and programs requires increases in taxation rates. Because new funds raised from increased taxes have not been forthcoming in many states, there has been a need in the past several years to reduce the magnitude of programs and levels of service in order to operate within available funding limits.

In addition to funding issues and problems within a state, there are external issues over which a state has little or no control. The types of external issues that have a major influence on transportation programs include:

- Federal funding and regulations for all modes,
- Fuel shortages and price increases,
- National and international economic influences, including inflation,
- National environmental policies, and
- Changes in financial priorities at the national level.

There are no quick and easy solutions to the problems listed above. Each state has its own problems and solutions. However, there are procedures currently being used that can be of assistance to states struggling with the problems discussed in this report.

The conclusions presented in the following sections of this chapter are based on the results of interviews with state officials and material gathered from 18 states.

TRANSPORTATION NEEDS STUDIES PROCEDURES

The purpose of a needs study and the anticipated use of the results must be clearly understood by both the people who perform the studies and those who will use the results. A "traditional" needs study that compares existing transportation services and facilities to "desirable" standards may provide results that have limited usefulness.

Needs studies often have not adequately considered bridge failures, pavement and subbase failures, and the structural integrity of the overall highway system. Most states have a comprehensive highway inventory data base, which is usually stored on a computer file and potentially very useful. Obviously, where it exists it should be used and kept up-to-date, but massive new data-collection efforts should be avoided. The available data should be used as cost-effectively as possible.

Separate needs studies must be done for each transportation mode because of the unique requirements and funding sources available for each mode. Tradeoffs between modes are seldom an issue, except within certain intraurban and interurban corridors where options may exist.

Traditional transportation design standards may have to be reduced (within the limits of safety) to allow for necessary reconstruction and rehabilitation within the constraints of limited funding. This is a critical issue and requires a reassessment of both national standards (e.g., AASHTO highway design standards) and state standards as well as substantial additional study.

Needs studies must produce results that are both understandable and credible. For example, if a highway needs study produces an estimate of $10 billion when a state anticipates spending $100 million per yr on programs, such a needs estimate will be incomprehensible and lack credibility (at $100 million per yr it would take 100 yr to meet all those needs). The "needs" must reasonably correspond to the funds likely to be available in order for the needs study to be significant.

The technical procedures used to estimate transportation needs vary from state to state, ranging from simple procedures using little or no comprehensive data to more comprehensive computer-based procedures.

USE OF TRANSPORTATION NEEDS STUDIES RESULTS

In developing balanced programs (i.e., balancing needs with funds), a solid data base and appropriate analyses must accompany the recommendations on funding levels. The availability of data and analyses will provide a substantial part of the backing necessary to provide credibility to program estimates. This is an especially important factor because continuity is essential when there are frequent changes in the offices of the decision makers, i.e., the governor, the secretary or commissioner, and the legislature.

The results of needs studies must be presented in clear, concise language. Without good communication between technical personnel and the governor, legislature, and citizens, it is impossible to convince people of the importance of high-priority problems and the need for adequate funding. All the problems identified by the needs analysis must be presented so that (a) the problems are understood by all those involved, (b) the available options for resolving the problems are clear, and (c) the impacts of alternative actions or inaction are recognized. This point cannot be emphasized strongly enough; people must understand the basis for transportation program recommendations and the implications of alternative actions. When presenting options within program categories, it is important to describe clearly exactly which programs or projects are to be included and which ones will be excluded or dropped. This will provide information to help people understand the impacts of available options.

In releasing and circulating data and information for review and comment, care must be taken to avoid overwhelming people with so much material at one time that it will be difficult to comprehend. It is also important to produce information that is believable. Any promises or commitments that are made must be implemented to avoid a loss of credibility in the future.

There is a consensus that it is essential for all legitimate

interests, geographic areas, and program categories to be treated equitably ("everyone must get a fair share of available resources"). This cannot happen each year, but should occur over a longer period of time. In establishing such an accounting of the distribution of those investments, previous expenditures as well as plans for future expenditures should be considered.

It is necessary to develop realistic long-range estimates of needs (the definition of long-range is uncertain, but probably on the order of 5 to 10 yr). This will add perspective and understanding to the shorter-term funding problems.

The results of needs studies provide a basis for establishing transportation program priorities. These priorities must be established in consultation with citizens, the legislature, and public and private interest groups. The total funding requirements for even the highest-priority transportation needs may exceed available resources. Thus analytical tools must be employed to optimize the use of the available funds. Analytical procedures must be flexible enough to provide for the adjustments needed when newly elected officials come into office, resulting in policy changes and new directions.

When it is impossible to provide additional funds for projects considered essential by transportation agencies, one or more of the following options must be chosen:

- Reduce the number of projects to be funded,
- Reduce design standards, or
- Downgrade projects (e.g., from a freeway to an arterial).

FUNDING DECISIONS

The best conceived or most soundly documented argument does not necessarily determine the nature or the magnitude of final funding decisions. Many factors must be considered, and they may be virtually impossible to document or quantify. A key factor is equity, and the definition of equity will differ from state to state.

When new or additional funds are needed, the final amount of money obtained may have no direct relationship to the technical analysis that was performed to justify such an increase. The final amount agreed upon will be determined through negotiations and compromises, involving many participants, within the state's political process. However, it is important to note that although the technical process may recommend $X and the political process results in $Y, there would probably be no increase if it were not for the technical process.

More consideration must be given (and is now being given) to the need for substantially improved maintenance of existing transportation systems. An increasing number of states have concluded that within existing constraints of state funding, it will be necessary to stop matching some federal programs in order to have adequate funds for 100 percent state-funded maintenance and operating programs. This is especially true for highways but applies to all modes. In past years the inability to increase state funds has resulted in less funds for maintenance programs because of the higher priority of matching all available federal programs. The priorities are now starting to shift as more recognition is given to the declining physical stability of the existing transportation network.

The ability to implement programs that have been selected represents a major part of the credibility of the entire process. If, for example, the governor convinces the legislature that new funds are needed for specific programs, it is imperative that those programs be implemented. Otherwise, the next time a similar request is made, it will be extremely difficult to convince the legislature of the need. A governor may be reluctant to commit to more than a 1- or 2-yr program because of concern over not knowing if it will be possible to implement a longer-term program.

If at all possible, a realistic and believable 5- to 10-yr program should be developed so that longer-term and continuing priorities can be established with enough flexibility to allow for necessary adjustments based on continuing updates. A longer-range program will also help to overcome the danger of "management by crisis." The selection of projects 1 yr at a time is often based on the bridges and highways or transit facilities that are in the worst condition. There is a danger of reacting instead of planning ahead, because it is difficult to determine the most realistic and cost-effective levels of funding required to avoid building up a huge backlog of essential projects that must be funded at some time in the future.

In determining the projects and programs to be funded and the program levels required, as much information as possible must be gathered and analyzed to determine:

- Impacts of taking specific actions,
- Impacts of *not* taking those actions,
- Long-term impacts of short-term decisions (and short-term impacts of long-term decisions), and
- Benefits and costs of alternatives when choices exist.

Officials and professionals must have confidence in their analyses and the presentation of their recommendations; they must avoid the withholding of vital information from the public and other participants in the overall process, which could be detrimental to selling the program.

The emphasis on highway programs has shifted from construction of interstate systems and expressways to preserving and maintaining existing facilities at a pace sufficient to prevent the need for major reconstruction and to maintain safe conditions. Thus increasing maintenance needs and rapidly rising costs will force the use of construction funds for maintenance purposes.

NEEDS STUDIES PARTICIPANTS

There are numerous private and public participants (both agencies and individuals) involved in defining transporta-

tion needs to fit constrained financial resources, all of whom may have different perspectives on the same problem and may use different criteria to set priorities. All these interests must be balanced. Those major participants in the process are:

- The governor and staff;
- The legislature and the staff of various legislative committees;
- The secretary or commissioner and staff;
- Department of transportation career personnel;
- Local elected officials;
- Other state, regional, and local agencies that may be directly or indirectly affected (including MPOs, transit agencies, etc.);
- Special commissions, blue-ribbon committees, and other special committees;
- Citizens groups;
- Public and private interest groups; and
- The news media.

The state legislators, who represent the public and determine how much money will be made available, are key actors in this matter and therefore must be involved in every step of the process. The degree of involvement of the legislature (or its appropriate committees) will, of course, be different in each state. However, every effort must be made by the state agency responsible for this program to keep the legislature fully informed.

The desire of the legislature to be kept informed may sometimes be resented by career employees or elected and appointed officials in the executive branch. They may fear that the impact of technical analysis and professional judgment will be reduced due to political pressure. However, if the technical analysis is sound, the results are understandable and realistic, and the responsible state agency has a credible track record, then there is little to fear. Cooperation and negotiation are the key to success.

CONCLUDING REMARKS

The credibility of the agency producing recommendations for transportation programs and projects is essential in obtaining funds. The analysis and resulting recommendations must be understandable and realistic; the presentation to the governor, the legislature, and the public must be accomplished in a professional yet simple manner so that people will both understand and believe the information. Only then can the necessary communication be established and progress be made.

After the commitments have been made to implement a particular program at a specified program level, the agency responsible for the program must produce the anticipated results. A suitable management control and information system should be established to ensure continuing control over the progress that is being made.

Finally, program managers should not become overly pessimistic if their recommendations for changes or expansions to existing programs are rejected. Experience indicates that requests for new funds are nearly always rejected. If the situation is critical enough to warrant it, requests should be submitted as often as necessary to find an appropriate compromise.

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APPENDIX

CASE STUDIES

The material used in preparing this synthesis was gathered from existing technical reports and from contacts with representatives from 16 states (Florida, Illinois, Iowa, Maryland, Massachusetts, Minnesota, Missouri, New Jersey, New York, Ohio, Oklahoma, Pennsylvania, Tennessee, Texas, Vermont, and Wisconsin). Interviews were conducted by telephone or in person, and written material was obtained from all but two of those states. Written material was also obtained from California and South Dakota, but personal contacts were not made. The states were selected on the basis of personal knowledge of work that was being accomplished in each of the states; however, the selection does not mean that other states are not doing equally interesting or unique work.

A discussion of general approaches to estimating transportation needs and developing the analyses and documentation procedures required to obtain funding approval for projects and programs, utilizing the material from the states listed above, is presented in Chapter 2. The purpose of this appendix is to provide a summary of actual practice in four states: Illinois, Massachusetts, Minnesota, and Wisconsin. The case study narratives have been developed to correspond, insofar as possible, to the 15 activities described in Chapter 2.

The four states selected for the case studies do not necessarily represent typical or ideal situations, nor were they selected by scientific methods. However, the techniques they use appear to be unique and interesting enough to warrant inclusion in this report. Their selection should not be interpreted to mean that other states are not doing unique or equally interesting work.

Finally, it is important to realize that it may not be possible to transfer a procedure or set of procedures exactly from one state to another; however some ideas may be directly or indirectly applicable.

ILLINOIS

Highways

Estimate Future Funding

Funds for maintaining and improving state and local highways come from four major sources (*22, 23*):

1. Motor fuel tax. In fiscal yr 1978 the $0.075 per gallon tax raised $430 million.

2. Motor vehicle registrations. In fiscal yr 1978 miscellaneous fees raised $312 million.

3. Bond funds. In recent years over $150 million in bond funds have been programmed annually.

4. Federal aid. Over the past 5 yr the state has obligated an average of $270 million per yr in federal aid for highways. Illinois' share under the 1978 Surface Transportation Act is expected to increase to about $580 million annually over the next several years.

A projection of gas tax revenues through fiscal yr 1984 is shown in Figure A-1. A projected revenue loss of $1.22 billion is anticipated at current rates of taxation.

During the period 1969 to 1973 vehicle registrations increased between 5 and 6 percent per yr. However, since 1973 growth has been only 2 to 3 percent. Thus another continuing loss in revenue is anticipated through fiscal yr 1984.

Further substantial increases in federal aid are not anticipated as the state has already received much more than can reasonably be expected in the future. Thus increased federal aid cannot be relied upon to make up substantial differences in lost revenues. Current bond authorizations are virtually exhausted, and extensive use of new bonds without additional revenues to pay debt service would be unwise.

Figure A-2 shows the loss in buying power available for state highway construction maintenance due to inflation. The 10-yr loss in buying power has been estimated to be $1.34 billion.

Finally, local sources of revenues (derived primarily from a portion of the motor fuel tax and local property taxes) are also expected to decline. Thus local officials may be forced to choose between either dramatic program reductions or property tax increases.

Determine Total Highway System Requirements

A comprehensive analysis of the entire state highway system was undertaken to determine deficiencies and cost estimates (*22, 23*). The study was a departure from traditional needs studies, which had been conducted by Illinois in the past. Two program categories were evaluated: (a) NOW projects—projects urgently needed now to maintain mobility and safety and preserve structural integrity; and (b) accruing requirements—capital and op-

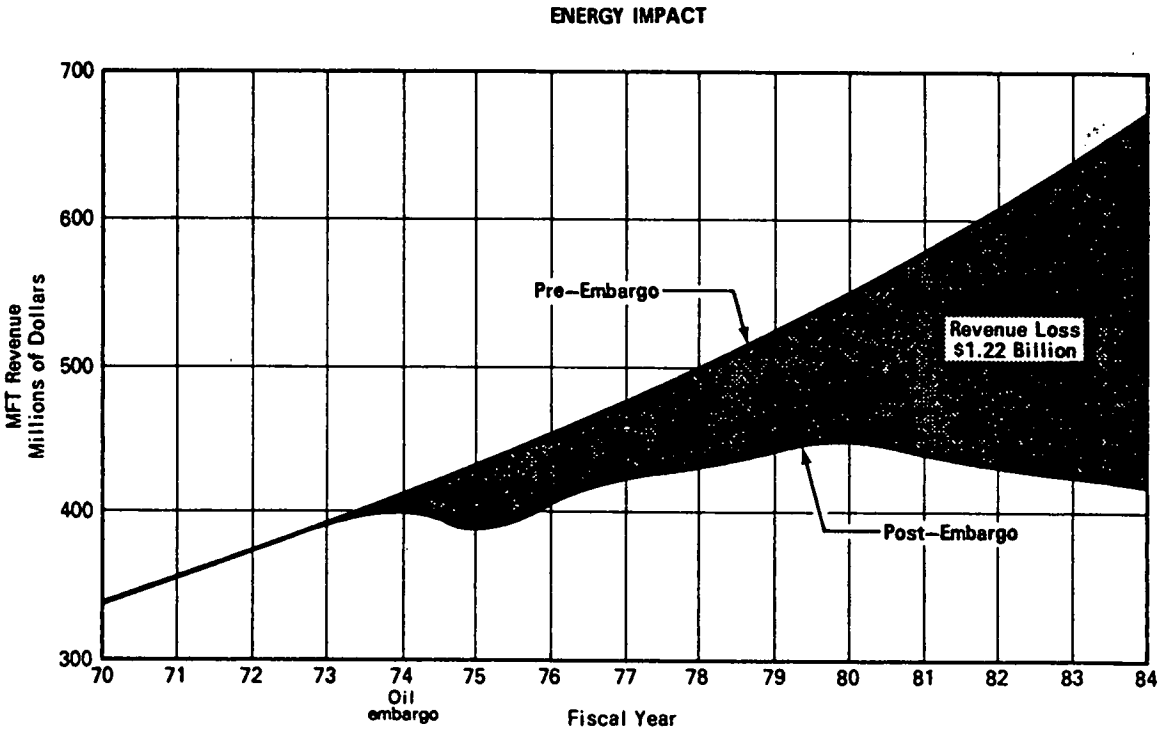

FIGURE A-1 Projection of Illinois gasoline tax revenues (*22*).

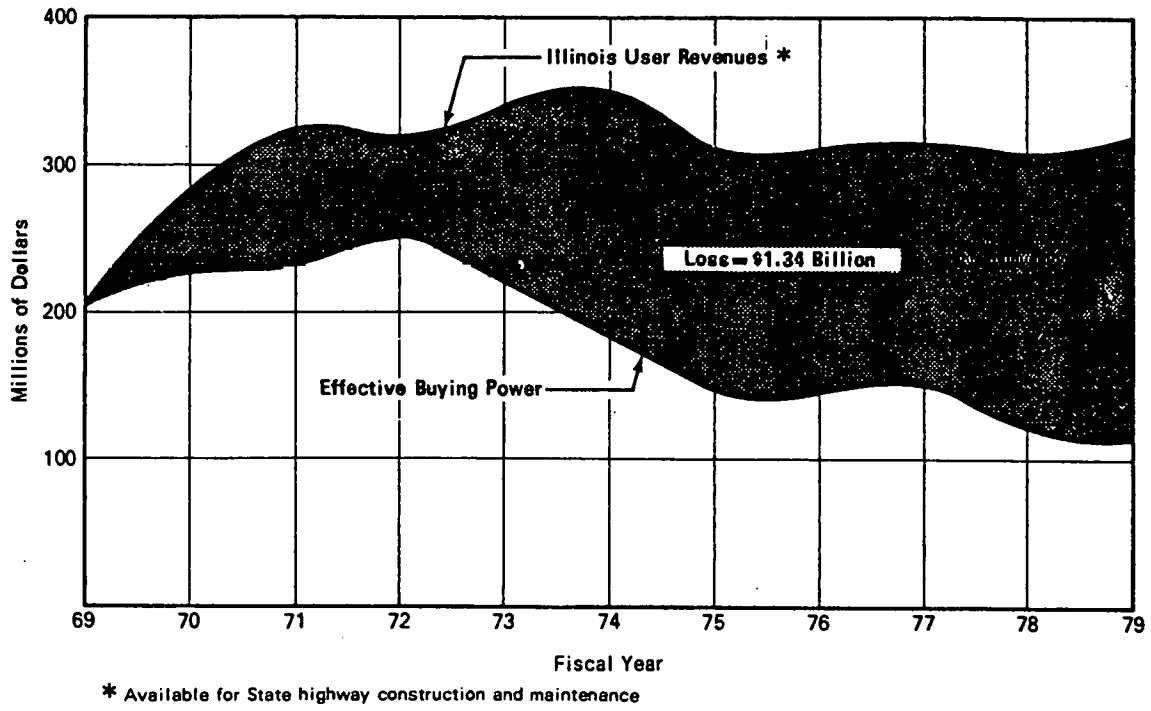

FIGURE A-2 Loss of buying power (Illinois) (*22*).

erating projects necessary to assure an adequate state highway system through 1999 for the time periods 1980 to 1984, 1985 to 1989, 1990 to 1994, and 1995 to 1999.

The procedure used to identify highway project deficiencies was based on a detailed data collection effort conducted by the Illinois DOT for the state highway system and by local and county highway officials for local streets and highways. In evaluating the need for NOW projects, data were compiled to provide factual and credible information needed to convince the governor, the legislature, and the public that certain high-priority projects needed current funding. The study was a departure from the traditional needs study in which conditions are compared to physical design standards in mechanical fashion. Instead, engineering judgment was used as a key element in making an honest assessment of current highway problems based on:

- Failing pavements,
- Bridges unable to carry loads,
- Unusually high maintenance costs,
- High accident rates, and
- Intolerable congestion and delay.

Judgment and written guidelines were the basic tools for project identification, but the basic test of a NOW requirement was that a project must be perceived by the general public as needed at present.

The estimates of accruing *resurfacing* requirements for the four time periods mentioned above were determined by an eight-step process:

1. Identify the condition of the current highway system.
2. Develop surface condition deterioration rates.
3. Differentiate between widening and resurfacing and resurfacing only.
4. Apply deterioration rates.
5. Evaluate the results.
6. Develop the costs.
7. Adjust the results.
8. Apply costs to determine accruing roadway needs.

Accruing *bridge* needs were determined for the existing system assuming there would be no traffic growth. Bridge replacement needs were based primarily upon the age of the structure, although a small number of structures (1.3 percent) were identified for which the number of lanes were increased because they were not adequate to carry existing traffic.

Accruing *maintenance* needs were derived from a mathematical model that gives the number of personnel required to maintain various highway types, such as two-lane rural, four-lane interstate, and urban highways. Personnel estimates, together with estimates of materials and equipment, provided overall maintenance cost estimates.

Criteria for Determining Deficiencies

Basic Objectives. To compare various program options and their overall impact on the highway system, program targets were determined to help in identifying the work with the highest priority. Program targets were established based upon the following basic objectives:

- To improve the level of service provided to the public by the department's ongoing maintenance and traffic operations programs, including pothole patching, snow removal, emergency vehicle patrol, and pavement striping.
- To restore existing roads at a rate to keep pace with the expected rate of deterioration due to age, weather, and traffic.
- To reduce the backlog of widening and resurfacing work required to correct narrow or rough roads and replacement or rehabilitation work to restore badly deteriorated bridges.
- To reduce congestion where necessitated by traffic growth and where conditions permit modernization of existing facilities.
- To proceed with limited new construction to complete the remainder of the interstate system and to complete usable segments for supplemental freeways already under construction. To the extent revenues are available, less expensive, nonfreeway construction would be undertaken in other high-priority supplemental freeway corridors.

Program Targets for State Highways and Bridges. The program targets defined here would complete the Illinois interstate system except for the Burnham Corridor, I-494, in Chicago, which would be started and partially completed. Already partially completed supplemental freeways would be completed into usable segments. Targets would preserve the physical state of existing high-volume routes and, where deficient, modernize them. Low-volume routes would also be preserved and modernized. Many critically deficient bridges would be replaced or rehabilitated and additional lanes would be added to certain high-volume routes in rapidly growing areas to maintain existing levels of service.

Program targets were established for the following categories of highway improvements:

- Interstate completion,
- Interstate modernization,
- Supplemental freeways,
- Preservation and modernization of high-volume routes,
- Preservation and modernization of low-volume routes,
- Replacement and rehabilitation of critical bridges,
- Reduction of traffic congestion,
- Reduction of the backlog of road deficiencies, and
- Maintenance and traffic operations.

Program Targets for Local Roads and Bridges. Local highway targets were based entirely on information provided by county and city officials throughout the state during the summer of 1978. This information included a comprehensive and specific evaluation of anticipated 5-yr problems and associated costs. Program targets covered the following categories of improvements:

- Resurfacing,
- Widening and resurfacing,
- Bridge replacement or rehabilitation, and
- Maintenance and traffic operations.

Identification of Deficiencies and Priorities

NOW Improvements. As indicated previously, critical projects, which were considered necessary by the public as well as by state and local highway officials, were identified. Thus priorities were established as the information was being developed.

Accruing Requirements. These were categorized as described above and grouped by the four time periods. Priorities were established by state and local officials, based on the program objectives as described above.

Funding Program Options

Three funding program packages were developed and labeled as follows:

- Option 1: Fall behind ($300 million annual program).
- Option 2: Keep pace ($750 million annual program).
- Option 3: Move ahead ($900 million annual program).

Within each of the three options there are also tradeoffs involving estimates of costs and services. Figure A-3 shows the three program packages and the major tradeoffs within each option.

Under option 1, there would be no tax restructuring or increases. Road taxes paid per mile would continue to decline, as they have for the past several years. Under options 2 and 3 there would be tax restructuring and tax increases. The amount of gasoline taxes paid per mile driven would increase slightly as would motor vehicle registration fees.

The following is an indication of the tax impacts of the three options. The data are based upon an Illinois motorist driving 10,000 miles (16 000 km) per yr in a new car getting 22 miles per gallon (9.4 km/L) in 1982, the mid-year of the NOW program. The typical motorist

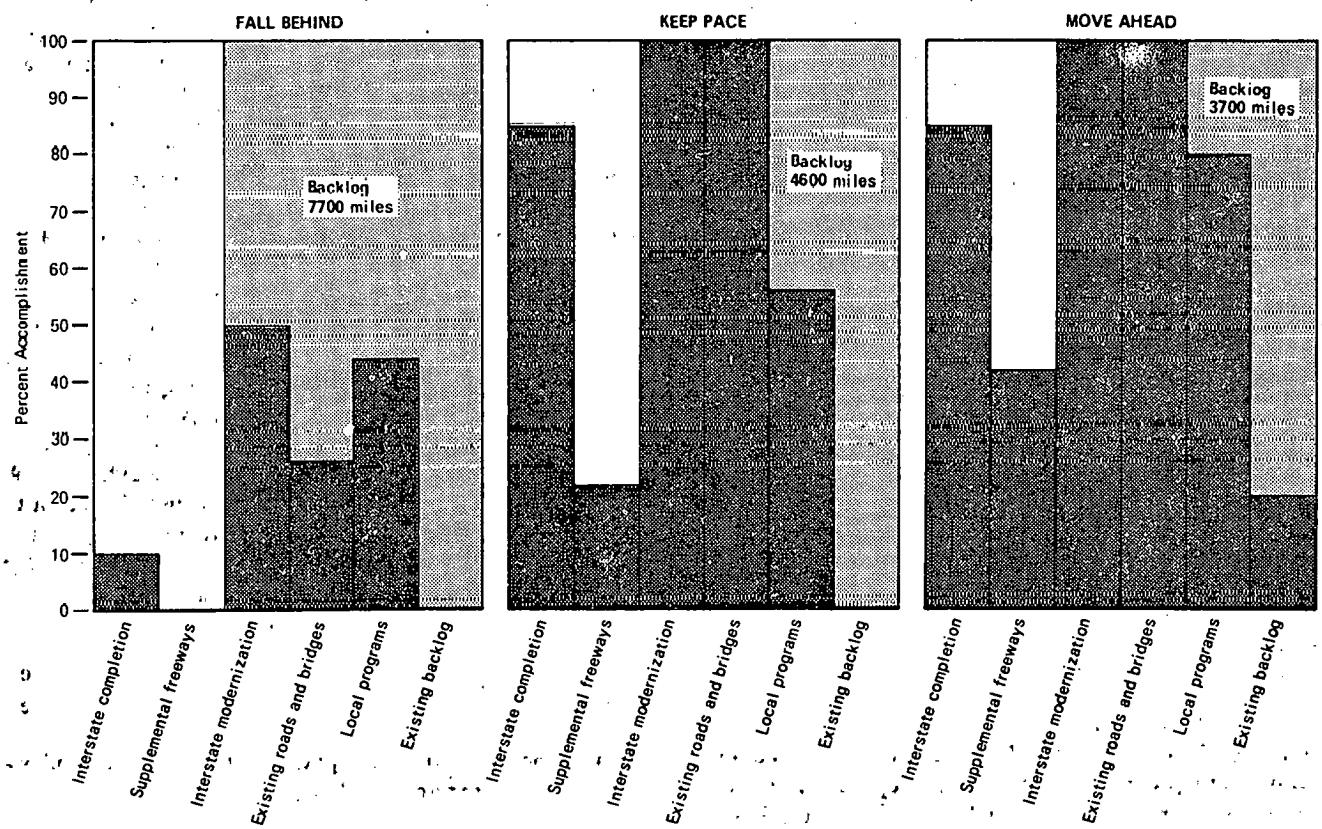

FIGURE A-3 Program comparisons (Illinois) (*22*).

would pay automobile user fees for the various options as follows:

- Option 1. The motorist would pay $10 *less* than the current payment.
- Option 2. The motorist would pay $11 *more* than the current payment, but still less than the 1972 payment.
- Option 3. The motorist would pay $24 *more* than the current payment.

A more detailed description of the three options listed and the tradeoffs considered within each option follows:

Option 1: Fall Behind. The fall-behind option would provide an annual average program of only $300 million, less than half the fiscal yr 1979 program size and only one-third the size of option 3, the move-ahead option. At the fall-behind level, the focus would be on preserving the existing system, but even here the program would fall short. The backlog of highway deficiencies would continue to grow, with a net increase of more than 2,000 miles (3 200 km) of rough pavement over the next 4 yr. The growing backlog of deficient bridges would not be addressed. At the same time, the pace of interstate construction would be slowed, and almost no supplemental freeway work would be performed.

The program would be designed to take advantage of federal funds to the largest reasonable extent, with almost all work concentrated on roads eligible for federal funding. Only emergency needs could be met on nearly 2,000 miles (3 200 km) of state highways that are ineligible for such funds. Despite this reliance on federal funds ($230 million of the $300 million program would come from this source), approximately $1.4 billion in available federal funds would be lost to the state over 4 yr from the lack of state matching dollars. At the local level, option 1 would provide no increase in motor fuel tax assistance because no new revenues would be available to the state.

In the short run, option 1 demands the least (no tax restructuring or tax increase); however, in the long run, it costs the most. It will involve additional costs to both the state and to the individual motorist. For example, the expense of road repair is far lower if done early; deferring a project can multiply the costs of eventual repair by as much as 4 times. If Illinois highways are allowed to deteriorate, the state's economy will suffer. Jobs generated by highway construction spending alone would drop from the current level of 72,000 to only 30,000. The 2,000 miles (3 200 km) of additional rough roads and the additional inadequate bridges would add to the transportation costs of existing highway users, both through increased motor vehicle maintenance expenses and through extra driving required by detours. Motorists would be exposed to greater accident risk and would consume more fuel.

Option 2: Keep Pace. With an average annual program of $750 million, the keep-pace option would meet many more program objectives than option 1. It could check the growth of road and bridge deterioration. It would also permit the completion of unfinished interstate segments, with the exception of the Burnham Corridor, and would allow the continued construction of freeway segments where investments have already been made. Unlike option 1, all available federal funds would be matched, and local governments would receive a $33 million average annual boost in motor fuel tax revenues, although the full $90 million in additional assistance provided by the move-ahead option would not be possible.

The keep-pace option would require no immediate tax increase, although it would require tax restructuring. This option would not make inroads on the size of the backlog of highway needs. As existing road and bridge projects were completed, new projects would arise to take their place. Illinois motorists and shippers would continue to pay additional costs in time, fuel, and dollars as the backlog of road repair needs remained constant.

Option 3: Move Ahead. Option 3, at an average of $900 million per yr, provides the largest program. It shares the advantages of option 2 in that it would (a) check the growth of road and bridge deterioration; (b) permit completion of the interstate, except for the Burnham Corridor; and (c) match all available federal funds. In addition, it would fund the completion of an additional 100 miles (160 km) of supplemental freeways as compared to option 2, and it would provide $90 million in supplemental motor fuel tax revenues to local governments. This added assistance to local governments should help check the deterioration of the 116,000 miles (190 000 km) of city, county, and township roads and relieve some of the pressure on local property taxes.

A major advantage of option 3 is that it is the only option that would permit a reduction and eventual elimination of the backlog of state road and bridge deficiencies. It would also permit the department to improve maintenance services such as snow removal and pothole patching. Option 3 does require a tax and fee increase; however, it would gradually reduce the reliance on bonding.

In summary, Option 1 would require the least effort, but would permit road and bridge deterioration to escalate, increase individual motorist's operating costs, run up the cost of repairs when they are finally performed, and provide a declining level of service for the movement of people and goods in Illinois. Option 2 would halt the rate of physical deterioration, but would do nothing to reduce the size of the existing backlog. Although it would avoid a tax increase, it would require both tax restructuring and continued bonding. Option 3 would not only provide all the program advantages of option 2, but it would also begin to retire the backlog of deficiencies and reduce some of the pressure on local property tax burdens. Clearly, all of the options affect the state's economic climate and ultimately the financial well-being of its citizens.

Evaluation of Impacts

In addition to the funding options and impacts, the following impacts were also considered (*22, 23*):

- *Economy.* Studies conducted in Illinois have shown that good highways encourage economic growth. Illinois'

well-developed highway system has contributed to its position of being first in the nation in agricultural exports and second in overall exports. In 1977 farm income was $6.6 billion from crop production. The highway system is used at many points to move the produce to the market place. Much of the coal mined in Illinois, which has the largest bituminous coal reserves in the nation, is also transported over the state's roads.

- *Safety.* Well-designed modern highways are 4 times safer than older, narrow roads. In 1978 there were nearly 600,000 traffic accidents in Illinois and the direct economic loss to individuals in the form of medical costs and vehicle repair was over $1.5 billion. More importantly, 2,150 people lost their lives in these accidents. Highways built to high standards and properly maintained will significantly reduce these human and economic losses.

- *Automobile Costs.* Potholes tear up tires, brakes, steering, and the suspension systems of cars and trucks. An estimated $44 million in costs for brake, steering, and suspension system repairs, tire damage, and additional fuel use are attributed to highway potholes and other problems in Illinois according to studies conducted by the Road Information Program (TRIP). Improved road surfaces and elimination or improvement of grades and curves would help in cutting these costs.

- *Convenience.* Congested intersections slow the movement of goods and people. In many central business districts, the average travel speed is less than 10 mph (16 km/h), and in rural areas, school buses and farm equipment must detour because of narrow or deficient bridges. Each mile saved reduces the operating cost by $0.22 ($0.14/km).

- *Energy Use.* Traffic delays and deteriorated roads increase fuel consumption by as much as 50 percent. Both rural resurfacing and urban traffic improvement will help to conserve fuel.

Results of Analysis

In March 1979 the Illinois Department of Transportation submitted a report (*24*) to the governor that provided the summary data on the three program options discussed above. The state legislature and the governor worked out a financial package to provide additional funding for both highway and transit programs.

The program provides for a comprehensive restructuring of highway and public transportation finances. It funds highway needs by eliminating existing diversions of road funds, by transferring sales tax revenues approximately equal to collections on the sale of gasoline to state and local governments for highway purposes, and by increasing the state series A bond authorization. The program eliminates the authority of the Chicago Regional Transportation Authority (RTA) to levy gasoline and parking taxes, ends state sales tax and license fee subsidies, and makes certain administrative changes broadening representation on the RTA Board and increasing accountability. In place of these taxes and subsidies, the RTA is authorized to impose a differentiated regional sales tax, and the state capital assistance program is to be expanded. The state transit bond authorization, which is currently almost exhausted, is to be extended.

This program will support a $900 million state highway program (nearly $1.1 billion when federal funds from the Chicago Crosstown Transfer are added to the program), and will provide a 24 percent increase in state assistance for local roads and streets. Although it does not provide the level of funding requested by the RTA, the plan gives the RTA a source of revenue that, when supplemented by a modest 10 percent fare increase, will generate sufficient funds for the efficient operation of public transportation services throughout northeastern Illinois. More important, this proposal, in concert with the Crosstown Transfer, will be able to generate a large capital-improvement program. If action is not taken, a total of $3.2 billion in federal highway transit funds earmarked for Illinois would be lost to other states over the next 4 yr.

The major features of this plan include new funding for city, county, and township roads and streets; a reduced level of funding for the RTA as contrasted with earlier proposals, with the difference being made up by a modest 10 percent fare increase (as opposed to the 30 to 50 percent fare increase currently being discussed); and a further reduction of the proposed RTA regional sales tax in the surrounding counties.

Other Modes

The Illinois Department of Transportation undertook a comprehensive evaluation of urban public transportation (*25*) and aviation (*26*) needs during 1978 and 1979. The following is a brief description of the procedures that were used in this evaluation.

Public Transportation Needs

The estimates of urban public transportation needs were based on published data reports of various regional transit authorities. Each transit agency published a Five Year Transit Program, and all projects and programs were included in a yearly transportation improvement program (TIP). These are the usual requirements of the Urban Mass Transportation Administration (UMTA) as a prerequisite for receiving UMTA capital and operating grants. Considerable state and local funds are needed to match federal funds and to finance operating and maintenance costs not supported by federal funds.

Aviation Needs

A detailed assessment of airport capital and operating needs covering the 5-yr period from 1980 to 1984 was

made for all publicly and privately owned airports. Information was derived from data submitted directly by local airport authorities and operators. About 50 percent of the publicly owned and 30 percent of the privately owned airports responded to the Illinois DOT request for data. In cases where local airports did not respond or where sufficient information was not available, the Division of Aeronautics provided available data from its files.

The primary objective of this study was to estimate the cost of providing adequate transport facilities to industries and other users, thereby encouraging an increase in economic activities in Illinois and precluding the possibility of industries leaving the state or reducing their activities.

Capital requirements were estimated by a three-stage process:

1. Determination of those projects required to restore existing deteriorated facilities and equipment to adequate condition.
2. Determination of those projects required to bring existing facilities and equipment up to adequate capacity and safety levels for (a) existing demand (aircraft operations and based and itinerant aircraft) and (b) safe operations.
3. Determination of those projects that will expand existing facilities when it is clearly evident that additional facilities will be needed in the immediate future to accommodate increased economic activity.

This approach is distinct from a traditional 20-yr needs study. Its objectives are (a) to identify all problems and needs of the airport system today and those that are anticipated during the next 5 yr, (b) to estimate costs of the projects considered necessary, and (c) to develop a total statewide picture of the investment level needed.

This study of aviation needs was not fiscally constrained; however, each airport operator was asked to prepare an estimate of projected revenues and operating expenses. No action has been taken yet in attempting to identify the funding programs most likely to meet projected needs.

MASSACHUSETTS

Highways

Estimate Future Funding

Revenues for all highway programs (construction, operation, and maintenance) are derived from four sources (*13*):

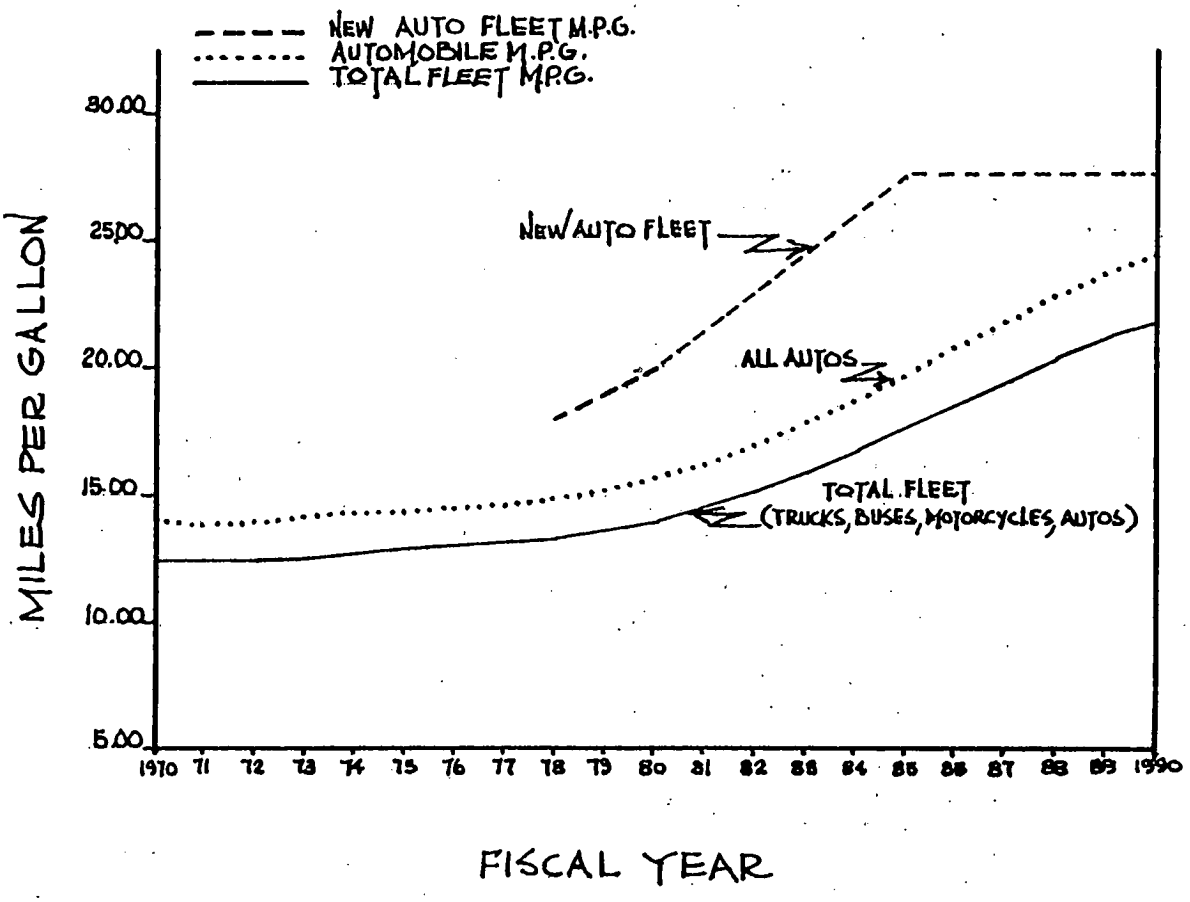

FIGURE A-4 Forecast of motor vehicle fuel economy (Massachusetts) (*13*).

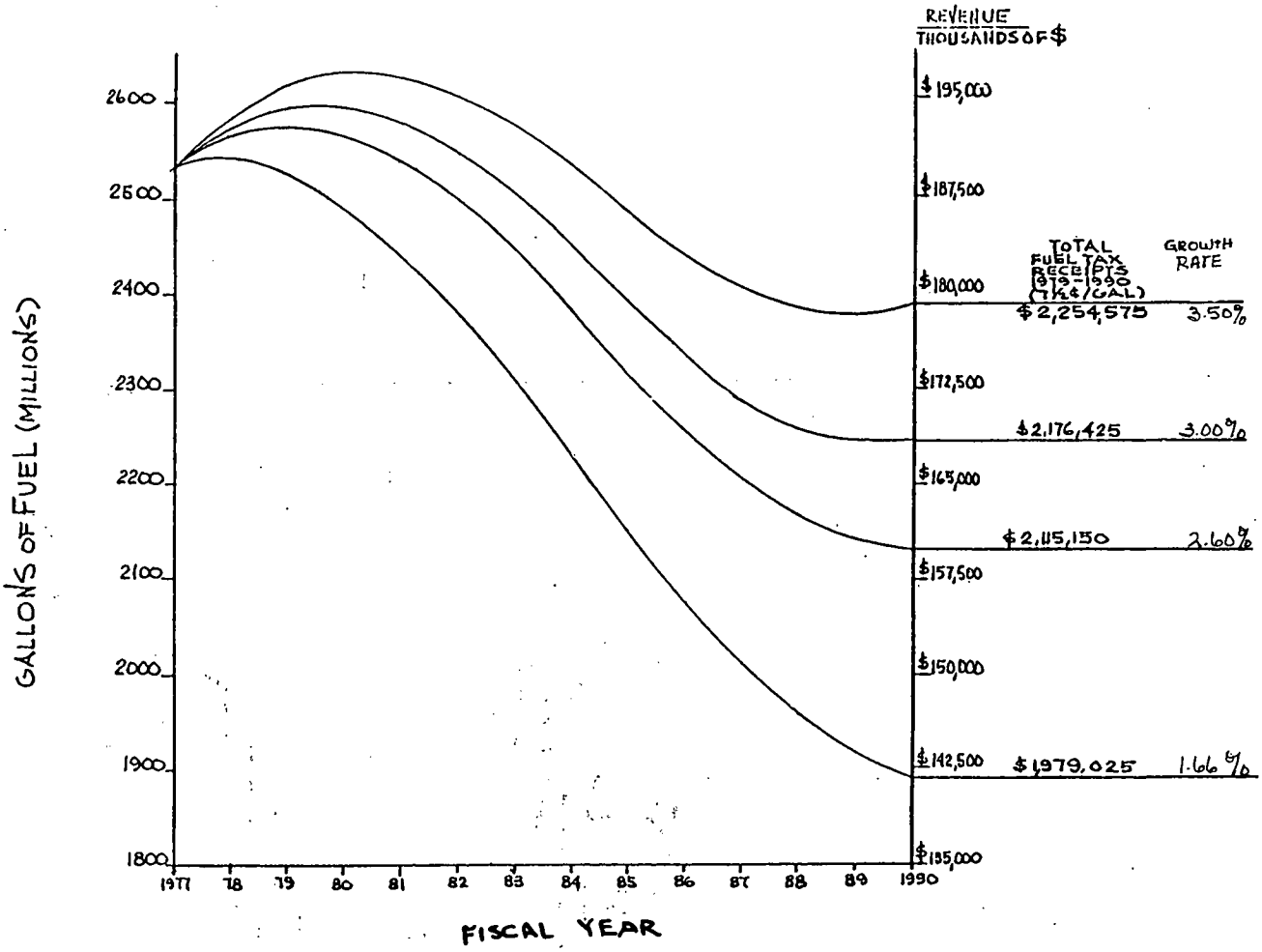

FIGURE A-5 Projected fuel consumption and fuel tax revenues in Massachusetts (*13*).

- Motor fuel taxes,
- Vehicle registration fees,
- Miscellaneous state funds including the general fund, and
- Federal reimbursements.

A major source of state funds used directly for highway programs is the motor fuel tax. A forecast of the average miles per gallon of the total motor vehicle fleet to the year 1990 was developed, based upon the federally mandated corporate average fuel economy standards. The results of that forecast are shown in Figure A-4.

Next, a forecast of annual vehicle miles of travel (VMT) was developed, using annual growth rates of 3.50, 3.00, 2.60 and 1.66 percent. Historically, VMT growth rates had averaged about 4 percent per yr until the oil embargo of 1973–1974. A growth rate of 2.6 percent was selected as the most reasonable, based on projections of reduced rates of growth for automobile registrations and licensed drivers, and an overall reduction in the rate of growth of vehicle driving within the state. Figure A-5 shows the projection of gallons of fuel consumed to the year 1990, based upon these factors, along with anticipated revenues derived from the existing gas tax.

Projections of vehicle registrations and the number of drivers were also made through a cooperative effort by the several state agencies responsible for motor vehicle registrations and the collection and distribution of fees. Similarly, projections were made of anticipated federal highway program reimbursements, based upon past experiences and expected federal aid highway program levels.

The results of these projections of revenues to be derived from all sources is shown in Figure A-6. At the current rate of taxation, a substantial reduction in available funds would occur beginning in 1980 and the downward trend would continue through 1990.

Determine Total Transportation System Requirements

Traditional highway needs studies had been conducted in Massachusetts for many years, the first one being done in 1945. However, the Massachusetts Department of Public Works (DPW) recognized that in light of the projections

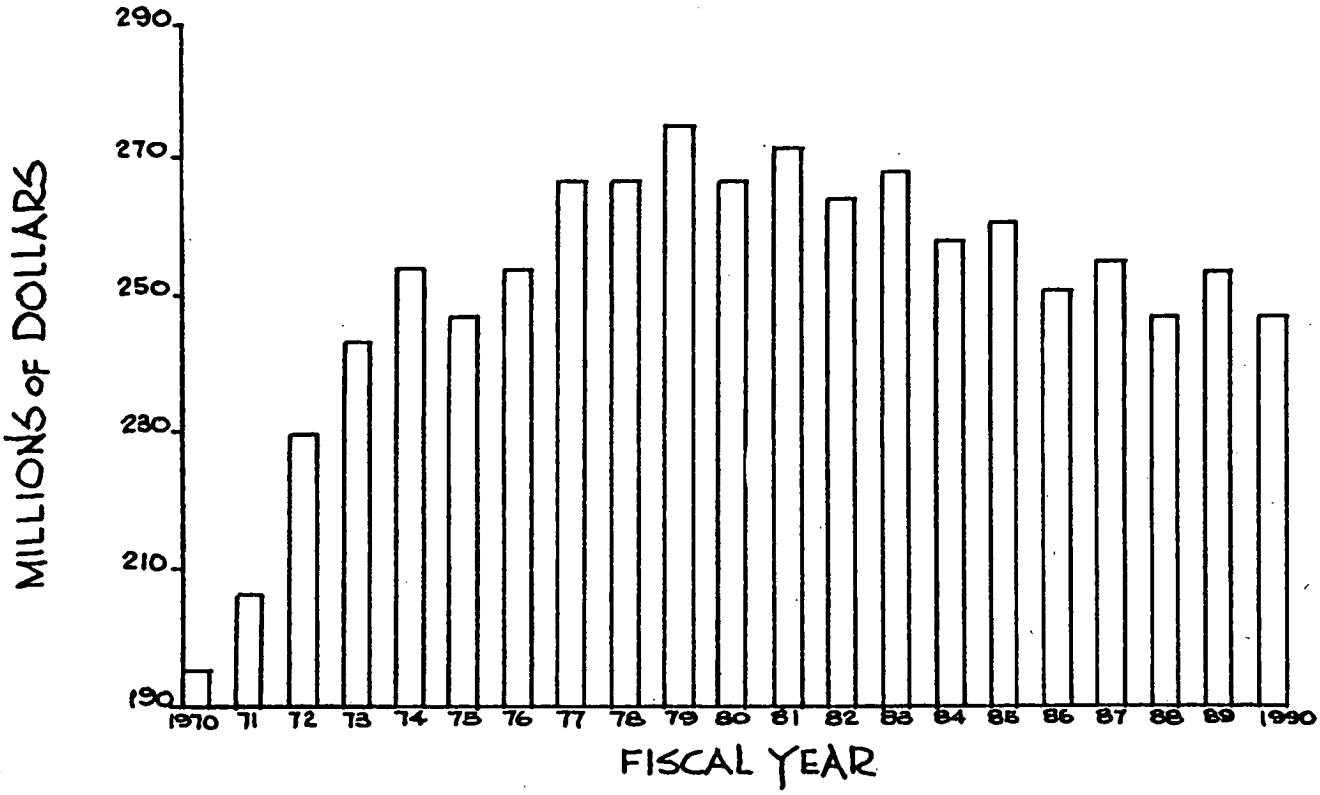

FIGURE A-6 Total revenue dedicated to Massachusetts highway fund (*27*). (Revenue includes motor fuel tax receipts, Registry of Motor Vehicles receipts, federal-aid reimbursements, and other non-motor-fuel receipts.)

of declining revenues and increasing program costs caused by inflation, a traditional financially unconstrained needs study would not be relevant or useful. Thus in early 1978 the department began a comprehensive assessment of highway needs based on a realistic appraisal of future financial resources (*28*).

Several alternative "needs" estimates were developed, based on previous statewide analyses and current input from citizens, local and state public officials, and regional and state agencies. The intent of this analysis was to identify the most critically deficient components of the state's highway system within the context of maintaining a sound highway system and at the same time contributing to the state's overall economic development goals.

System needs were identified by using a combination of high-priority capital and maintenance projects that had been previously identified as being critical (including the need to complete the interstate highway system) plus critical projects identified within each of the state's 12 planning regions (which incorporate every community in the state) as part of the comprehensive, cooperative, and continuing (3C) transportation planning process. Thus previous comprehensive studies, analyses, and public hearings provided the technical and political basis for assessing highway needs. Capital projects were summarized by funding program category for the entire state, and for each of the state's 12 planning regions.

Maintenance needs were of great concern to the state, because maintenance budgets for personnel, supplies, and equipment had been reduced substantially in recent years. A year-by-year budget was established for each of the major categories of maintenance programs instead of attempting to breakdown maintenance needs by geographic areas. Necessary budgets were established instead of estimates of needs in order to provide a realistic assessment of the minimum funding required to ensure a tolerable level of service.

Finally, a separate set of needs estimates was also developed for personnel requirements (planning, design, construction, and maintenance) and for the requirements of the agencies that derive partial funding from highway revenues.

Criteria for Establishing Priorities

Criteria were established to determine the projects and programs that would be funded by the limited sources projected to be available to the year 1990 (*27, 29*). For the construction program the criteria were:

- Maximize the federal-aid highway funds apportioned to Massachusetts.
- Reconstruct and rehabilitate old and unsafe bridges and highways within existing rights of way.
- Complete the interstate highway system already under construction.
- Build limited new highway mileage.
- Coordinate with existing and planned transit programs.
- Assist in the reduction of energy consumption.
- Contribute to the national and state goal of minimizing air pollution.
- Assist in the achievement of the growth policy objectives of state and local government.

For the maintenance program a major effort was to be made to establish the minimum budgets needed to provide an adequate level of maintenance throughout the state.

Develop Funding Program Packages and Options

Highway needs estimates were prepared for the five categories of programs that derive revenues from the Massachusetts highway fund (*27, 29*). Program funding options were then developed within each of those five categories. This procedure provides the commissioner of the Department of Public Works with the opportunity to evaluate a variety of options for advancing projects to fit the projected revenues, and also provides the information needed to determine the impacts of implementing *options* within each category. The "needs" and corresponding funding requirements for Massachusetts' highway programs are grouped in the following five categories:

1. *Capital program:* includes the funds needed to build new bridges and highways and reconstruct existing bridges and highways.
2. *Maintenance program:* includes the funds necessary for supplies and equipment for the routine housekeeping activities such as resurfacing, sweeping, grass cutting, catch basin cleaning, etc., as well as for the major effort required for snow and ice control.
3. *Personnel service and administration:* includes the funding needed for salaries and support facilities to implement the capital and maintenance programs.
4. *Funding to state agencies* other than the DPW for services provided directly to the state's highway program.
5. *Local aid* to each of the state's cities and towns.

A range of estimates of highway needs was analyzed to evaluate the impacts of various funding strategies that would serve the minimum requirements for the state's highway program. The following is a summary of alternative "needs" estimates for each of the five program categories listed above.

1. Capital Program. Six options were analyzed for various program funding levels. All options assume a continuing state policy of bond sales as the basis for funding capital programs instead of a pay-as-you-go policy that would require all expenditures for current programs to be paid from current revenues.

- No Build Option. Under this option all new capital program activity would have stopped at the end of 1978. However, there would still be a need for $729 million in state funds through the year 1990 to continue paying the principal and interest on bonds that have already been sold.
- Limited Build Option—Program Based Only on State Bonds Authorized But Not Yet Sold. Sufficient state funds had already been authorized and appropriated by the legislature to match all federal apportionments made to Massachusetts through the period ending September 30, 1978. If all those funds were obligated for projects and no additional new capital programs undertaken through 1990, there would be a cumulative need for $859 million in state funds through 1990 to pay the principal and interest on all outstanding bonds. This obligation would extend beyond 1990, because all the bonds that would be sold would not mature until the year 2002.
- Match All Anticipated Federal Apportionments Through 1990, Not Including the Central Artery. This option assumes that the highway construction program will continue to be planned on the basis of developing projects to match all available federal highway funds that are apportioned to Massachusetts. It is not based on an estimate of the costs to build specific projects (as described by the following options). This option excludes the cost to complete the proposed Central Artery Project in Boston. (This proposed project would provide for the depression of an existing elevated highway within the city.) The total state funds needed to implement this option to the year 1990 is estimated to be about $1.06 billion.
- Match All Federal Apportionments Through 1990, Including the Central Artery. This is the same as the preceding option, except that it assumes that the Central Artery will be depressed at an estimated cost of more than $1 billion. This assumes that the north section of the project will begin in 1982, the central section will begin in 1989, and the south section will begin in 1988. The total state funds required through 1990 will be about $1.084 billion. However, additional state debt service costs would be incurred beyond 1990. This estimate assumes that only a small portion of the cost to complete the Central Artery would be incurred prior to 1990—about $24 million in state funds. However, the total cost to complete the Central Artery is estimated to require a total of about $1.35 billion in federal funds; $150 million in state matching funds (excluding interest) would be needed beyond 1990.
- Projects-Based Option Without the Central Artery—Program Based Upon the Cost Needed to Implement Projects Currently in Some Stage of Development. Approximately 1,000 highway projects, ranging in cost from $100,000 to tens of millions of dollars, are in some stage of development at the present time. These projects have received endorsement or are currently undergoing extensive review and analysis throughout the state. It is estimated that the cost to complete those projects (or similar projects) would require state funds totaling about $1.238 billion through 1990. This option does not include the proposed Central Artery Project in Boston.

• Projects-Based Option with the Central Artery. This is the same as the preceding option, except that it includes the cost to complete the Central Artery project in Boston. The total state funds needed to implement this option through 1990 is about $1.262 billion. This assumes the same construction schedule for the Central Artery as described for the preceding option.

2. Maintenance Program. A major priority of the Department of Public Works is the maintenance of existing state-administered bridges and highways. Estimates of future needs for maintenance equipment and supplies are summarized below. These estimates do not include personnel needs, which are covered in the following section.

• Reduced Maintenance Effort. This option assumes that the level of funding authorized for FY 1979 would continue at the same amount each year through 1990. Because of the anticipated yearly increases in costs of maintenance equipment and supplies due to inflation alone, this option would result in a real-dollar reduction in maintenance activities each year. The total state funds required through 1990 would be about $335 million under this option.

• Trend Growth Option. The cost of highway maintenance has grown steadily despite service and personnel reductions during the past several years because of the increased costs of supplies, equipment, and personnel. A straight-line projection (adjusted for anticipated snow and ice control costs) of the growth in the dollar amounts for maintenance supplies and equipment based on past experience results in the need for about $420 million through 1990. This represents about a 5.1 percent increase per yr.

• Agency Forecast. A detailed estimate of maintenance needs was developed by the maintenance department of the DPW based on an estimate of the requirements for a reasonable and cost-effective program through 1990. This estimate assumes that a simple trend projection of past expenditures does not provide adequate funds to undertake a minimally acceptable maintenance program. The total projected costs through 1990 are about $457 million, representing an average increase of about 6 percent per yr.

• Selected Forecast. Based on a detailed analysis of alternative methods of forecasting future DPW maintenance expenditures, it was concluded that a more realistic forecast for maintenance needs would provide the DPW with a maintenance budget of $37 million per yr, which is an average of $11 million per yr greater than the level funding alternative. With this alternative, a total of $445 million would be expended for maintenance activities over the 12-yr period.

3. Personnel Service and Administration. There were about 4,700 employees at the DPW at the beginning of FY 1972. That number was reduced to about 4,600 at the end of FY 1974, and further reduced to 4,400 at the end of FY 1975 and to about 4,100 employees by the end of FY 1976. The number of employees, including all categories of personnel (administrative, engineering, planning, maintenance, and other support staff), has remained at that level through the end of 1979. It is assumed that a ceiling of 4,100 people will be maintained through 1990 and that a total of about $882 million will be needed in state funds to support that level of staffing.

4. Funding to Other State Agencies. The Massachusetts Highway Fund supports a portion of the highway-related activities of seven state executive and constitutional offices in addition to the Department of Public Works.

Four alternative projections of needs, similar to the options analyzed for maintenance program needs, were made for this category.

• Reduced Level of Support. This option assumes that the level of funding authorized for FY 1979 would continue at the same amount each year through 1990. Because of the unavoidable yearly increases in personnel and equipment costs, this option would result in a real-dollar reduction in the support of other agency needs. However, the total state funds required through 1990 would be $1.196 billion.

• Trend Growth Option. A straight-line projection of past expenditures by the other state agencies was developed to estimate future needs. This option assumes a continued growth in these needs with no constraints. The accumulated 1990 needs totaled $1.602 billion.

• Agency Forecasts. Each of the seven state agencies were requested to estimate their needs on a yearly basis through 1990. The cumulative total amount through 1990 was $1.534 billion.

• DPW Estimate of Other Agency Needs. A fourth estimate of other agency needs was developed to determine a realistic assessment of future requirements. This was accomplished by evaluating the three options described above, and either concurring in a particular forecast or establishing a compromise position based on an effort to use uniform assumptions. This evaluation resulted in a total 1990 needs estimate of $1.562 billion.

5. Local Aid. Since 1971 $0.01 from the state motor fuel tax has been dedicated for use by the 351 cities and towns of Massachusetts. Beginning in FY 1980 (July 1, 1979), an additional $0.005 from the current state gasoline tax was dedicated to the cities and towns. The $0.01 per gallon local-aid program has amounted to about $25 million per yr. However, because of the anticipated decrease in the use of gasoline forecast to the year 1990, that amount will decrease to about $21 million per yr by 1990.

Based on the assumption that $0.015 per gallon will be dedicated for use by the cities and towns beginning July 1, 1979, and assuming that practice will continue through 1990 at a reduced total amount each year (based on a reduction in gasoline consumption), a total of $410 million will be dedicated to the local-aid program from the highway fund through FY 1990. This amount will range from about $38 million per yr in 1980 to about $32 million in 1990.

Recommendations for Programs and Levels of Funding

The options described above were analyzed in detail, and the following recommendations were made by the DPW:

- The most realistic estimate of the highway construction program needs through 1990 is the fourth option listed under the Capital Program. This estimate is based on the anticipated federal apportionments through 1990, including the Central Artery, and it results in the need for about $1.084 billion in state funds for the 12-yr period. This option was selected because (a) that level of capital funding is roughly equivalent to the projects that are likely to be ready for construction during that period, and (b) the state should take full advantage of all the federal funds that are likely to be available to assist in developing better transportation service and in the further stimulation of the statewide economy.
- The DPW will maintain a constant level of employment of about 4,100 people through 1990. About $882 million in state funds will be needed for personnel and administrative costs. About $134 million in federal reimbursements is anticipated for personnel services.
- DPW maintenance needs are best reflected by the fourth option listed under the Maintenance Program. This is the funding level necessary to maintain a highway system at minimum tolerable standards in terms of safety and operations. It will require about $445 million in state funds for the 12-yr period.
- The seven other state agencies that derive portions of their funds from the maintenance account will continue to do so through 1990. A modest increase in needs will also continue through 1990, as reflected best by the fourth option under Funding to Other State Agencies. This will require about $1.562 billion.

The projection of costs to implement the selected options as compared to the revenues forecast to be available from existing taxes resulted in the conclusion that a cumulative deficit of about $1.3 billion would occur by 1990.

Based on this conclusion, Table A-1 gives the additional revenues needed on a year-by-year basis through 1990 in terms of increased motor fuel tax rates. These revenues are based on the revenues derived from the curve shown in Figure A-6. As can be seen in Table A-1, the *existing* $0.085 gasoline tax in Massachusetts would have to be doubled by 1989 to implement the recommended program; an immediate $0.02 increase would be needed in 1979, with another $0.01 increase necessary in 1982.

Evaluate Possible New Sources of Revenue

The DPW analyzed 10 options for dealing with the problem of inadequate funds to finance what were considered to be minimum program needs.

1. Reduce the magnitude of the highway construction program, the maintenance program, the number of personnel, and the other services funded from highway-generated revenues.
2. Transfer funds from the general fund to the highway fund.
3. Remove the funding of state agencies other than the DPW from the maintenance account.
4. Increase the motor fuel tax.
5. Transfer a portion of the existing sales tax on motor vehicles to the highway fund.
6. Increase the registration fees on passenger cars and motorcycles.
7. Increase the registration fees on trucks.
8. Increase driver license fees.
9. Increase inspection fees.
10. Implement a combination of the above increases.

The purpose of the analysis was to provide the governor and the legislature with the technical support necessary to

TABLE A-1
INCREASES IN EQUIVALENT MOTOR FUEL TAX RATES TO FUND RECOMMENDED PROGRAMS (*27*)

	1979	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	Total[a]
Highway Maintenance Account[b]	$0.02	--	--	--	--	$0.015	--	$0.015	--	$0.005	$0.01	--	$0.065 increase
Debt Service Account[c]	--	--	--	$0.01	--	--	--	--	$0.01	--	--	--	$0.02 increase
Total Increase in Motor Fuel Tax Rates	$0.02	--	--	$0.01	--	$0.015	--	$0.015	$0.01	$0.005	$0.01	--	$0.85 increase

[a] The total tax rate may be derived by adding the increase to a $0.08 base through fiscal year 1980, and to a $0.07 base thereafter.

[b] Based on a modest increase, due to inflation, for Funding to Other State Agencies; Selected Forecast for DPW Maintenance Needs; and DPW employment remaining at 4,100 people through 1990.

[c] Based on matching all anticipated federal apportionments, including the Central Artery.

make a decision on the most appropriate funding and program options.

Negotiate Funding and Program Options

The legislature's Joint Committee on Transportation evaluated and ultimately adopted an eleventh option for consideration by the full state legislature. The Committee's recommendation was to convert the current $0.085 per gallon tax to a 15 percent excise tax levied on the wholesale price of gasoline. (At the then-current price, the 15 percent would have produced about $0.085 per gallon.) The Transportation Committee narrowly supported the proposal, and it was defeated in the summer of 1979 in a vote by the full house of representatives, apparently for the following reasons:

- The timing was bad. The proposal was made at the time when gas lines were long and the price at the pump was increasing rapidly. The legislature was understandably reluctant to be blamed as a fourth villain (i.e., in addition to OPEC, the oil companies, and the federal government) in the dramatic events being experienced by the residents of Massachusetts and the nation.
- A major marketing effort was needed to convince the constituents of the legislature that the proposed funding program (which required additional taxes) was important. Much of the staff work in developing and explaining this new taxing scheme was accomplished by the Transportation Committee staff, which was not large enough to handle all of the work that was required.
- Most of the newspapers throughout the state initially rejected the proposed percentage tax. However, a limited but concerted staff effort, which produced technical analyses to document the need for such a tax increase, resulted in a remarkable turnaround by nearly all the state's major newspapers, which eventually supported the proposal as being necessary and timely. However, this support came too late to change the mind of the legislature.
- The newly elected governor had pledged that he would enact no new taxes, and thus there was no support from the executive branch for the new tax proposal. Without full executive *and* legislative support, the proposal was severely handicapped.

The highway fund was being partially financed from general fund revenues in 1978 and 1979 because the motor vehicle user revenues were no longer adequate to meet the demands for funds. With the defeat of the percentage tax proposal, a decision was needed either (a) to continue to use existing general fund revenues or (b) to decrease the magnitude of the program to match available funds from current highway user revenues. The governor proposed that the legislature extend indefinitely three state taxes (two of the taxes were for transportation purposes) that had been enacted temporarily in 1975 for a 5-yr period to finance the borrowing of short-term funds needed to overcome a severe fiscal crisis in 1975. That money would raise about $60 million per yr and would temporarily make up the difference between revenues from current sources and anticipated program costs. The proposal was approved by the legislature. It provided temporary relief, but only for a 2- to 3-yr period.

Other Modes

The need to raise additional state revenues for the Massachusetts highway program was related to the needs for other transportation programs (*30*). The reason for this relationship is that state bonds are sold to provide the construction funds required to match federal capital funds. Thus raising additional funds through the motor fuel tax was necessary to provide the continuous funding of highway and mass transportation improvements.

The additional revenues that were eventually endorsed by both the governor and the legislature provided the funds to support the sale of bonds for the 2-yr programs presented in Table A-2.

TABLE A-2
EXPENDITURES APPROVED BY MASSACHUSETTS LEGISLATURE FOR VARIOUS PROGRAMS
(millions of dollars)

	State Bonds	Federal Funds	Total Program
Highways	$ 169.60	$ 312.00	$ 481.60
Urban Transit	75.00	300.00	375.00
Airports	1.50	6.80	8.30
Rail Freight Program	2.85	1.00	3.85
Totals	$ 248.95	$ 619.80	$ 868.75

The needs estimates for urban transit, airports, and rail freight programs were developed by the responsible state agencies, regional agencies, and MPOs as appropriate (i.e., for urban programs sponsored by U.S. DOT). A process of negotiation was also undertaken by the executive and legislative branches of the state government to arrive at a 2-yr compromise of program expenditures.

MINNESOTA

Highways

This case study was prepared in the fall of 1979. Since that time, Minnesota has revised the data and information to reflect both higher inflation rates and decreases in fuel consumption, which resulted in decreased revenues. For the most current data, see a later report prepared by the Minnesota Department of Transportation (*31*).

Estimate Future Funding

The methods used to forecast revenues were a combination of traditional practices (accounting for predictable changes) and skills gained from past experience. Several state agencies assisted the Minnesota Department of Transportation (Mn/DOT), particularly the Department of Finance. The following factors were considered in developing revenue forecasts for highway projects:

- Inflation and its resulting reduction in the value of the dollar, and a forecasted reduction in the rate of growth in diesel and gasoline consumption.
- Increases in maintenance and construction costs, as measured in price indexes.
- Constant level of anticipated federal funds.

Figures A-7–A-10 show the data used to account for inflation, gas consumption, and the increase in the highway construction and maintenance cost indexes. Figure A-11 is a composite chart showing past and projected state revenues (based on current rates of taxation) through 1985 and their relationship to anticipated construction and maintenance programs. Two significant conclusions can be drawn from Figure A-11: (a) by 1983 the state will run out of 100 percent state funds and experience a shortage in federal-aid matching funds; and (b) by 1985 there will be no federal-aid matching funds for capital programs.

Determine Total Transportation System Requirements

In 1976 the Minnesota Highway Department conducted a traditional highway needs analysis. That study concluded that the cost to bring the 12,000-mile (19 000-km) trunk highway system up to national standards would be $4.3 billion over a 20-yr period, exclusive of the cost to complete the interstate highway system.

A comprehensive transportation plan covering all modes of transportation was developed for the entire state during 1977 and 1978 (*8, 11, 32, 33*). The development of that plan was undertaken within a framework of broad citizen participation throughout the state, and included an analysis of existing financial resources as well as the development of a 6-yr capital improvement program.

Within the total estimate of highway needs, citizen input produced $2.3 billion in priority projects, including $1.7 billion to rehabilitate the existing 12,000-mile (19 000-km) trunk highway system with no expansion or modernization. Also included was more than $600 million in outstanding bridge rehabilitation needs. Mn/DOT officials concluded that the state could never satisfy all of the $2.3 billion of "needs" that were estimated for the entire state. This huge estimate of highway system needs made it clear that compromises and adjustments would have to be made and that it would not be possible to bring the highway system up to modern standards or to accommodate all the needs expressed by the citizens of the state. It also became clear that Minnesota would be entering a period of system

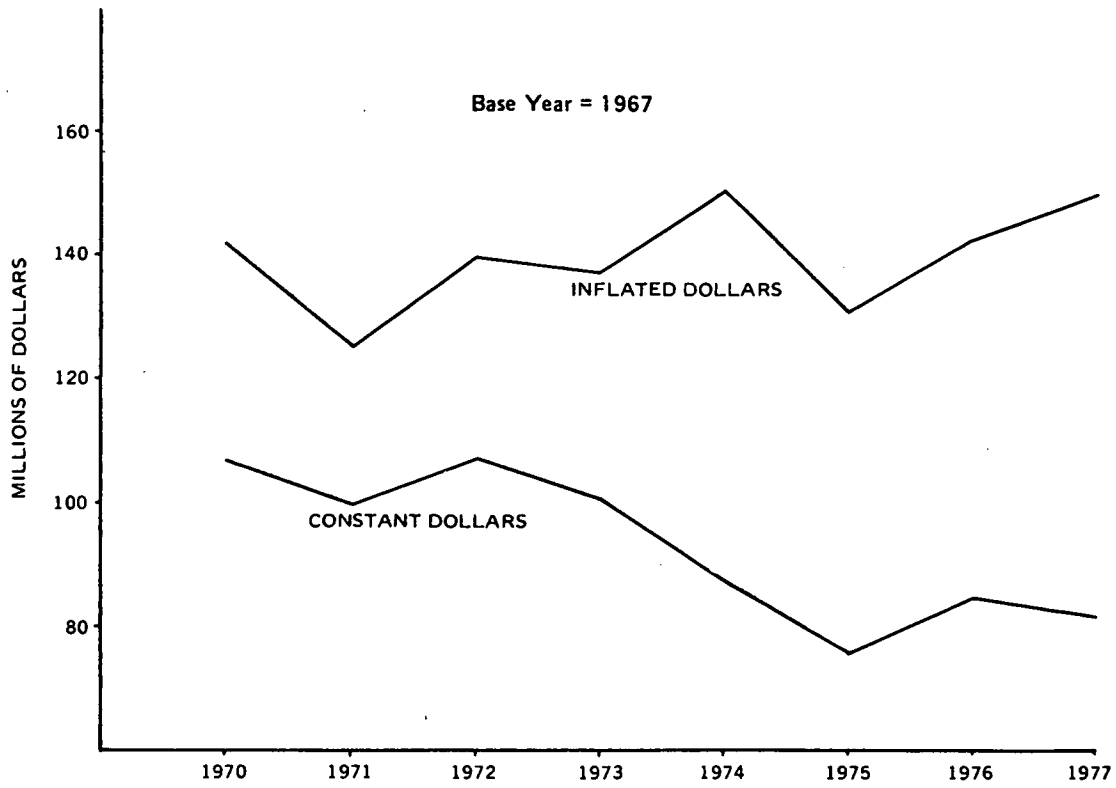

FIGURE A-7 Mn/DOT Capital Program (with inflated and constant dollars) (*8*).

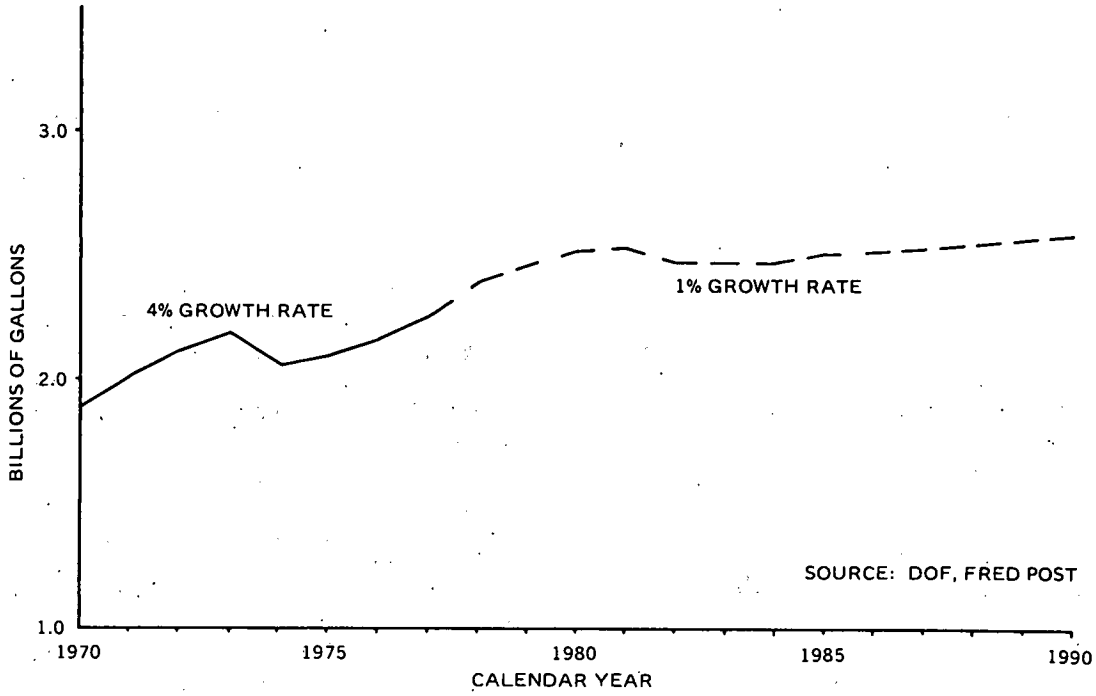

FIGURE A-8 Minnesota gasoline consumption (historic and projected) (*8*).

management and maintenance instead of continued system expansion.

Criteria for Establishing Priorities

A 5-yr (1980–1985) capital improvement program was developed based on the following criteria (*33, 34*):

- Maximize federal funds at the level anticipated over the next few years.
- Emphasize rehabilitation and maintenance of the existing highway system.
- Invest in the highest-priority regular state trunk highway projects to the extent permitted by limited funds, using as criteria for regular trunk highways: (a) cost effectiveness, (b) sufficiency rating, (c) functional class, (d) invest-

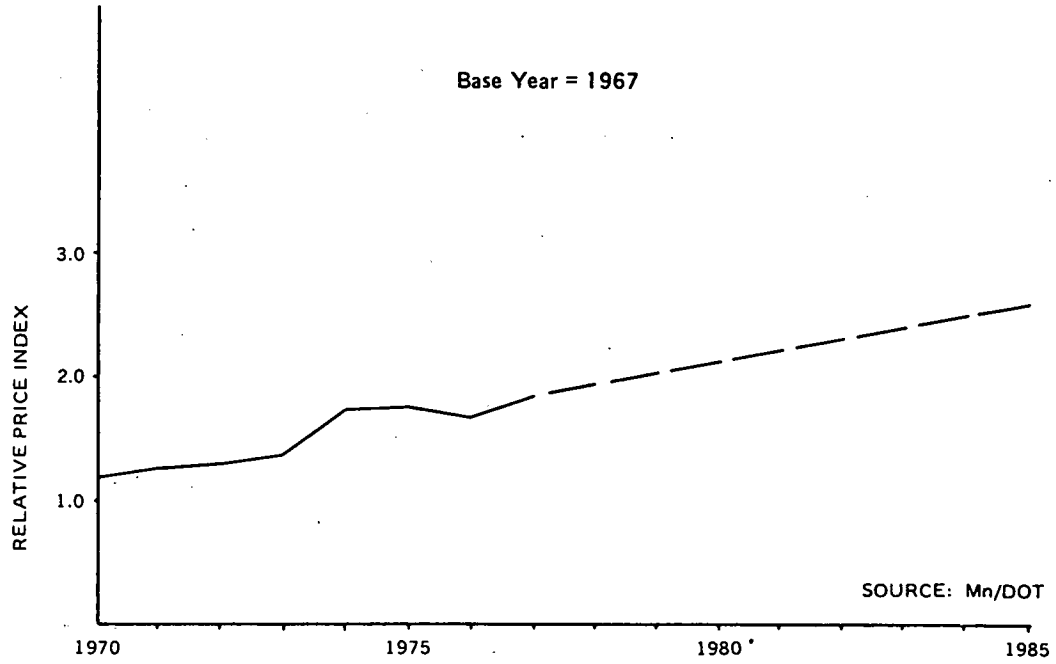

FIGURE A-9 Highway construction bid price index (historic and projected) (*8*).

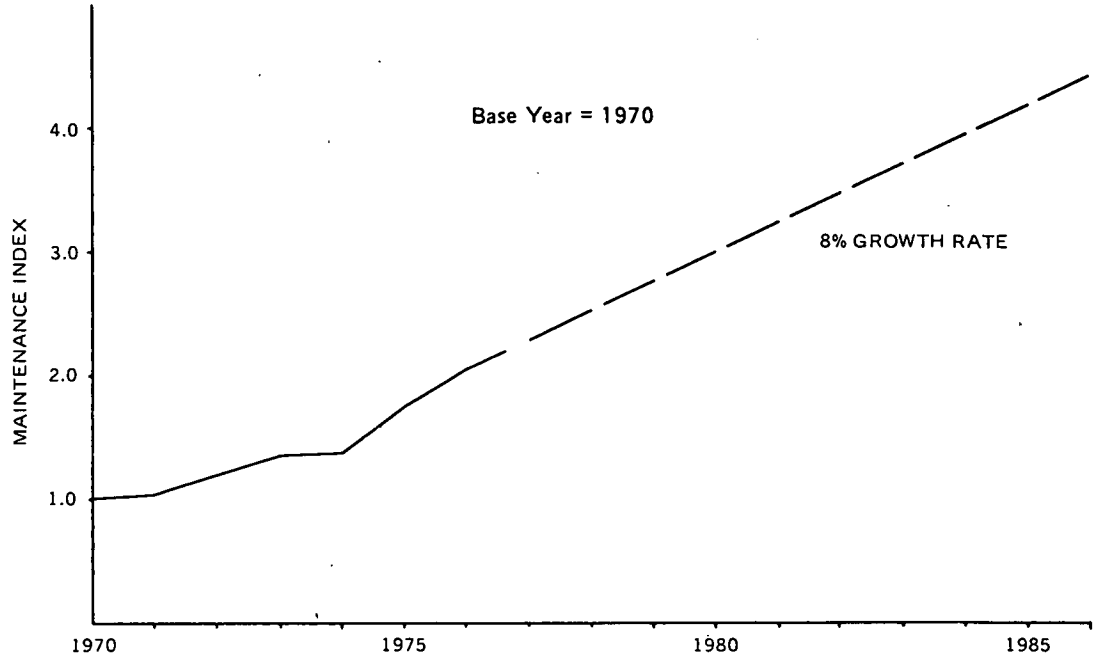

FIGURE A-10 Maintenance index (historic and projected) (*8*).

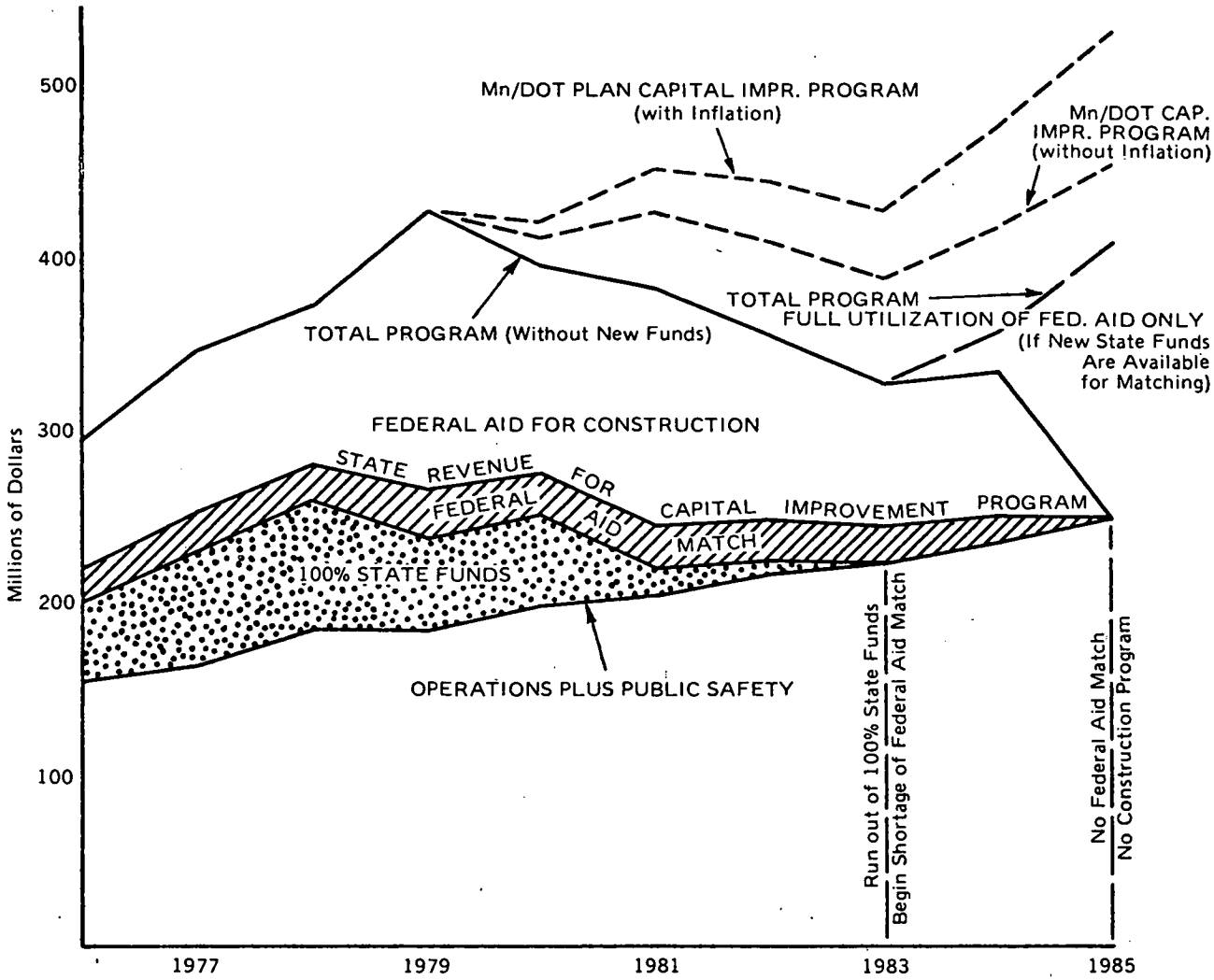

FIGURE A-11 Mn/DOT highway revenues and expenditures (historic and projected) (*8*).

ment levels possible, and (e) other technical considerations. Criteria for resurfacing and minor improvements were (a) condition rating, (b) cost effectiveness, (c) functional class, and (d) other technical considerations.

- Complete the interstate system by September 30, 1986. (This would require awarding $800 million in interstate construction projects by that date.)

Develop Funding Program Packages and Options

Table A-3 presents four funding options prepared by Mn/DOT for the 1980–1981 biennium (covering 2 fiscal years) (*34*). The four options emphasized the use of available plus proposed additional funds for maintenance (option 1), maintenance plus small investment in new construction (option 2), maintenance plus moderate investment in new construction (option 3), and maximum investment in new construction but no significant maintenance projects (option 4).

The Mn/DOT 1980–1981 highway capital improvement program had strong support from the public at public hearings and from public agency reviews in the fall of 1978 for the concept of maintaining a constant level of effort. A constant level of effort would provide for (a) maximizing federal funds, (b) a timely completion of the interstate system, and (c) a continued emphasis on the rehabilitation and maintenance of the existing system. However, it would also require an additional $70 million in state funds for the 2-yr period (option 3 in Table A-3).

Evaluate Possible New Sources of Funding

The Minnesota Department of Transportation analyzed and proposed to the state legislature a mechanism to stabilize the state's highway program—the consumer price indexed fuel tax (*33*). This proposal was not accepted by the legislature; however, the following brief summary is presented for those who might be interested in this concept.

The consumer price index (CPI) is developed by the U.S. Department of Labor for 28 different metropolitan areas throughout the United States. It is a statistical measure of the average change in prices for a fixed market basket of goods and services. Mn/DOT proposed that the CPI for the Minneapolis–St. Paul metropolitan area be used to index state fuel taxes.

Figure A-12 shows that the increase in the Minneapolis–St. Paul CPI has roughly approximated the increase in the Minnesota highway construction cost index. Analysis indicated that linking the motor fuel tax to the CPI instead of to the highway construction cost index would have the advantage of providing a more stable revenue source without the cyclical and sometimes sudden fluctuations that occur in construction costs. It was recommended that the CPI fuel tax be adjusted on an annual basis and be based on changes in the CPI during the preceding 12-month period. The per-gallon tax on fuel would be adjusted to the nearest $0.001. A floor of $0.09 per gallon would be established (the current tax), and all changes in the cents-per-gallon tax would be calculated using that base rate.

Several alternative CPI proposals were evaluated. The program selected for presentation to the legislature proposed a June 1, 1979, implementation date and a tax rate adjustment (+9.3 percent) based on changes in the CPI between January 1978 and February 1979. This adjustment would have provided a tax of $0.098 per gallon on June 1, 1979. The estimated additional revenue during the 1980–1981 biennium totaled $56.6 million, which would have provided a major portion of the additional funds needed to fund the recommended capital improvement program described previously.

TABLE A-3
MN/DOT HIGHWAY CONSTRUCTION PROGRAM AND OPTIONS FOR FY 1980–1981 BIENNIUM
(millions of dollars) (*35*)

OPTIONS	OPTIONAL CONSTRUCTION PROGRAM LEVELS	STATE FUNDS REQUIRED	FEDERAL FUNDS UTILIZED	TOTAL DEVELOPMENT CONT. PROG.	WHAT THE FUNDING LEVEL BUYS NUMBER OF (PROJECTS) DOLLARS					R/W AGREE AND MISC.	NEW STATE FUND REVENUE REQUIRE
					RESURF.	SAFETY	MAJOR TH CONST.	BR. REPAIR	INTERSTATE		
1	BIENNIAL BUDGET LEVEL	$ 86	$291	$377	(17)$16	(68)$14	(37)$ 86	(40)$12	(50) $174	$75	$ 0
2	BIENNIAL BUDGET WITH TSM/MAINT. EXPANSION	$130	$291	$421	(46)$37	(80)$15	(44)$103	(40)$12	(50) $174	$80	$44
3	MN/DOT/PLAN LEVEL	$156	$291	$447	(60)$45	(108)$19	(54)$117	(40)$12	(50) $174	$80	$70
4	MN/DOT/PLAN PLUS CATCH-UP ON PROJECT DEFERRALS	$182	$291	$473	(64)$50	(108)$19	(63)$130	(40)$12	(50) $174	$88	$96

EXCLUDES BRIDGE REPLACEMENTS DONE UNDER A SEPARATE BUDGET AUTHORITY

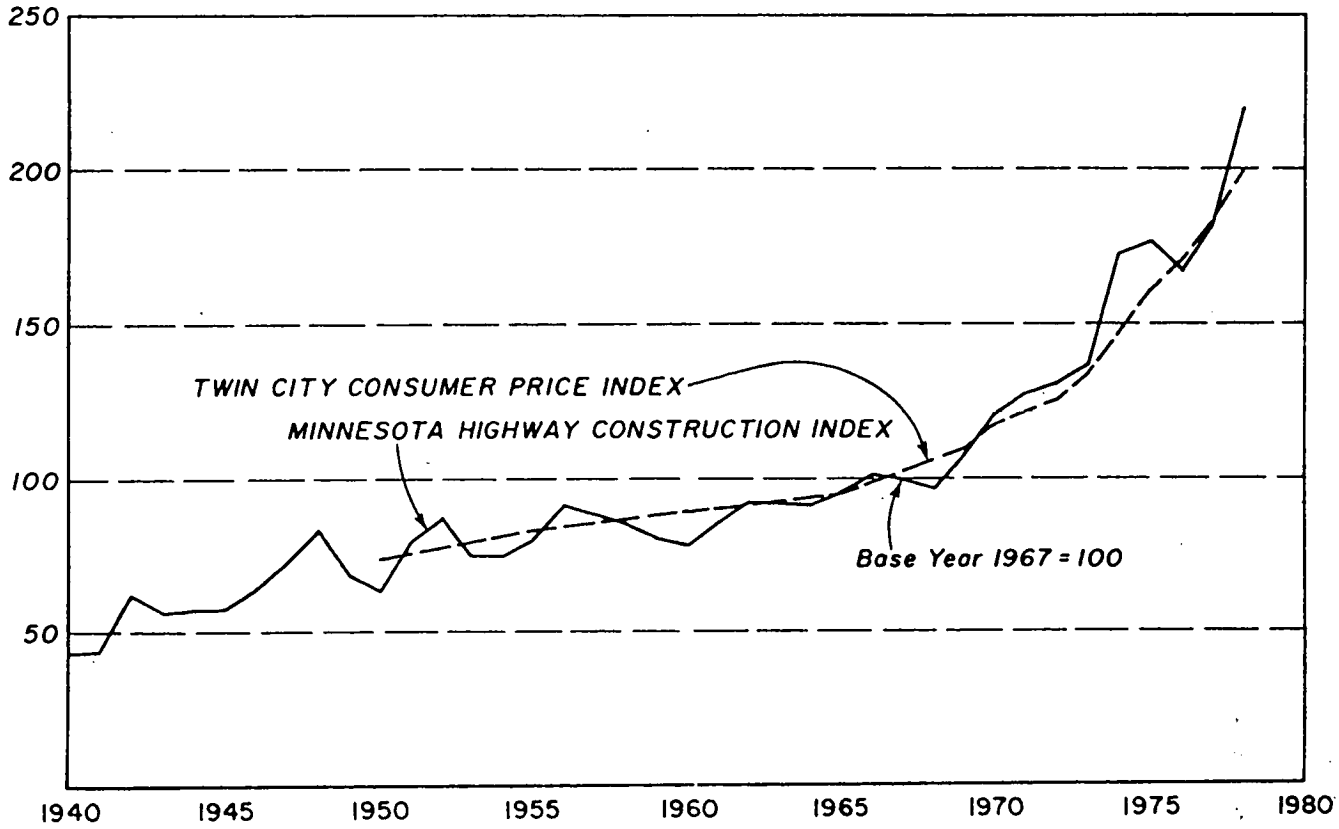

FIGURE A-12 Historic trends of the Minneapolis–St. Paul consumer price index and highway construction cost index for Minnesota (*33*).

Negotiate Funding and Program Options

Because the state legislature did not approve additional revenues for the 1980–1981 biennium, Mn/DOT was required to defer approximately 60 percent of the projects in the federal-aid primary category. A summary of projects to be let and projects to be deferred in the Mn/DOT plan was also prepared and distributed. Table A-3 was prepared to illustrate 1980–1981 project deferrals and 1982–1985 projects now unscheduled.

Other Modes

The Minnesota Department of Transportation has published two documents that present transportation system needs and priorities through 1985 (*8, 32*). Those documents identify transportation needs and propose capital improvements for aeronautics, bikeways, highways and streets, intercity passenger transportation, pipelines, railroads, transit and paratransit, and waterways.

Projected needs and revenues are estimated for each mode. However, the revenue forecasts for highway needs are the most comprehensive. It is expected that a more detailed analysis of the other modes will eventually be undertaken.

WISCONSIN (*35–39*)

Highways

The Wisconsin Department of Transportation (WisDOT) recently completed a comprehensive evaluation of highway program needs (*35*). WisDOT defines programming as part of a four-level decision-making process, translating the general guidance available from broad policy and system-wide studies into a practical and realistic near-term course of action. Figure A-13 summarizes the four levels of the decision-making process.

The 6-yr highway program of WisDOT is the product of a recent program development process that was given top priority in establishing and refining the continuing process of highway programming. Figure A-14 presents a flow chart of that 10-step programming process (35).

Estimate of Future Funding

In the development of its 6-yr highway program, WisDOT used a trend analysis of revenues from current sources to determine future funds that would be available for highway purposes (*35, 36*). The current three sourecs of highway revenues are (a) state motor vehicle revenues obtained

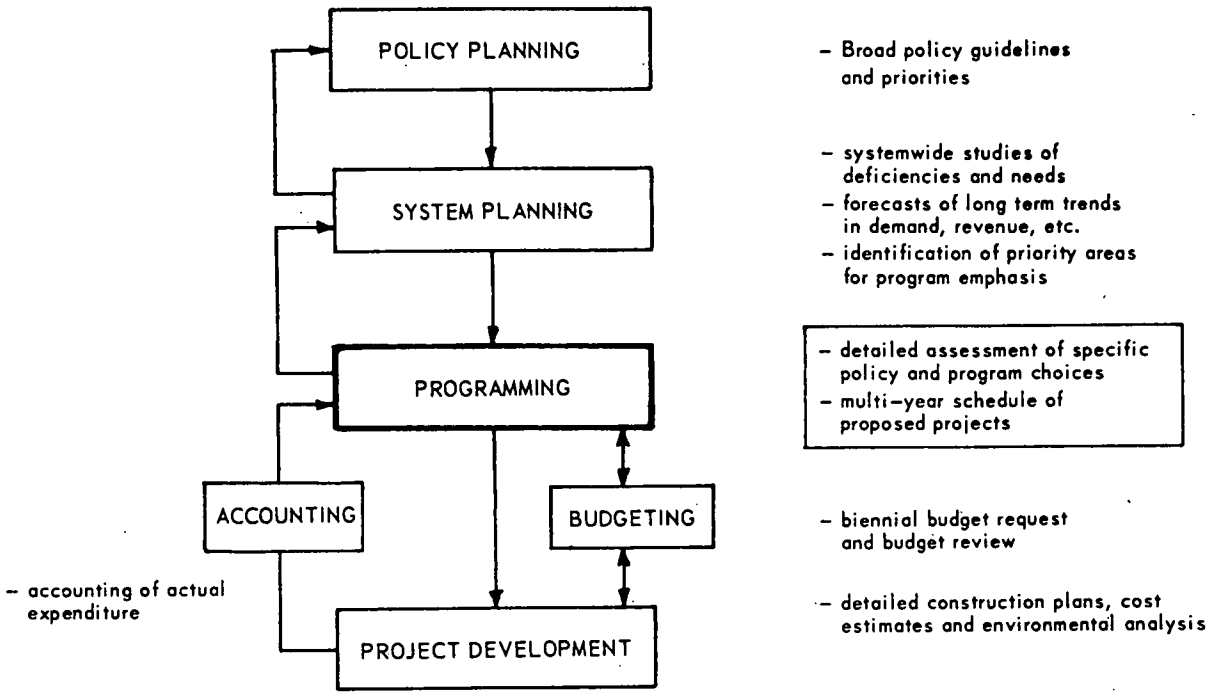

FIGURE A-13 Levels of the decision-making process (Wisconsin) (*35*).

from the fuel tax, vehicle fees, other miscellaneous user fees, and the general fund; (b) federal aid; and (c) highway bonds.

The analysis included consideration of the increasing rate of inflation in the construction industry, the increasing competition for motor fuel revenues, and rapidly increasing maintenance costs. Figure A-15 illustrates the problems in balancing highway costs and revenues. For the 12-yr period of 1967–1978, state gross motor vehicle revenues increased by 50 percent while the construction price index doubled. As a result, the buying power of the gross revenues actually decreased by about 75 percent from the 1967 level, as shown in the bottom graph of Figure A-15.

At current trends, the state will not be able to match all available federal funds in 1982 if levels of federal participation remain constant.

Determine Total Highway System Requirements

WisDOT specifically rejected the old needs study approach of comparing the existing highway system to a set of modern design standards in order to arrive at an estimate of needs (*35–37*). Instead, they first established deficiencies in the four program areas:

- The 3R program—covers the state trunk highway system (STH) and includes all resurfacing and reconditioning and some of the lower-cost reconstruction work on the state system (the RRR program area).
- Major projects—includes the high-cost, high-visibility reconstruction, new highway and, in some cases, bridge replacement work on the state system. (These projects were included in a separate category because of costs, multiyear financial commitments, legislative and outside interest, and unique evaluation and priority criteria.)
- Interstate—includes all major work done on the interstate system. (This program is considered separately because of the high federal priority and unique funding provisions).
- Bridges—includes bridge replacement projects. (This area is considered separately because of the increasing priority of this problem and the availability of a separate category of federal aid for these projects.)

The deficiencies in the highway system were established with full consideration of the levels of funds that were likely to be available for each program area. Projects were ranked from greatest needs or worst conditions to those requiring less work.

A set of data was collected on the highway sections mostly likely to require work over a 6-yr period, which was about half of the total state highway system (6,000 out of nearly 12,000 miles). The selection of mileage was made by districts based on surface renewal needs and was based on the following criteria: surface age and condition; accident rates and occurrences; volume to capacity ratios; percent no-passing zones; and geometric criteria. Data were collected, coded (on a standard form), and then placed in a computer file.

Develop Criteria for Determining Deficiencies

State Trunk Highways and RRR Program. Structured judgment, using the criteria described above, was used to complete standard forms. In addition, a pavement service-

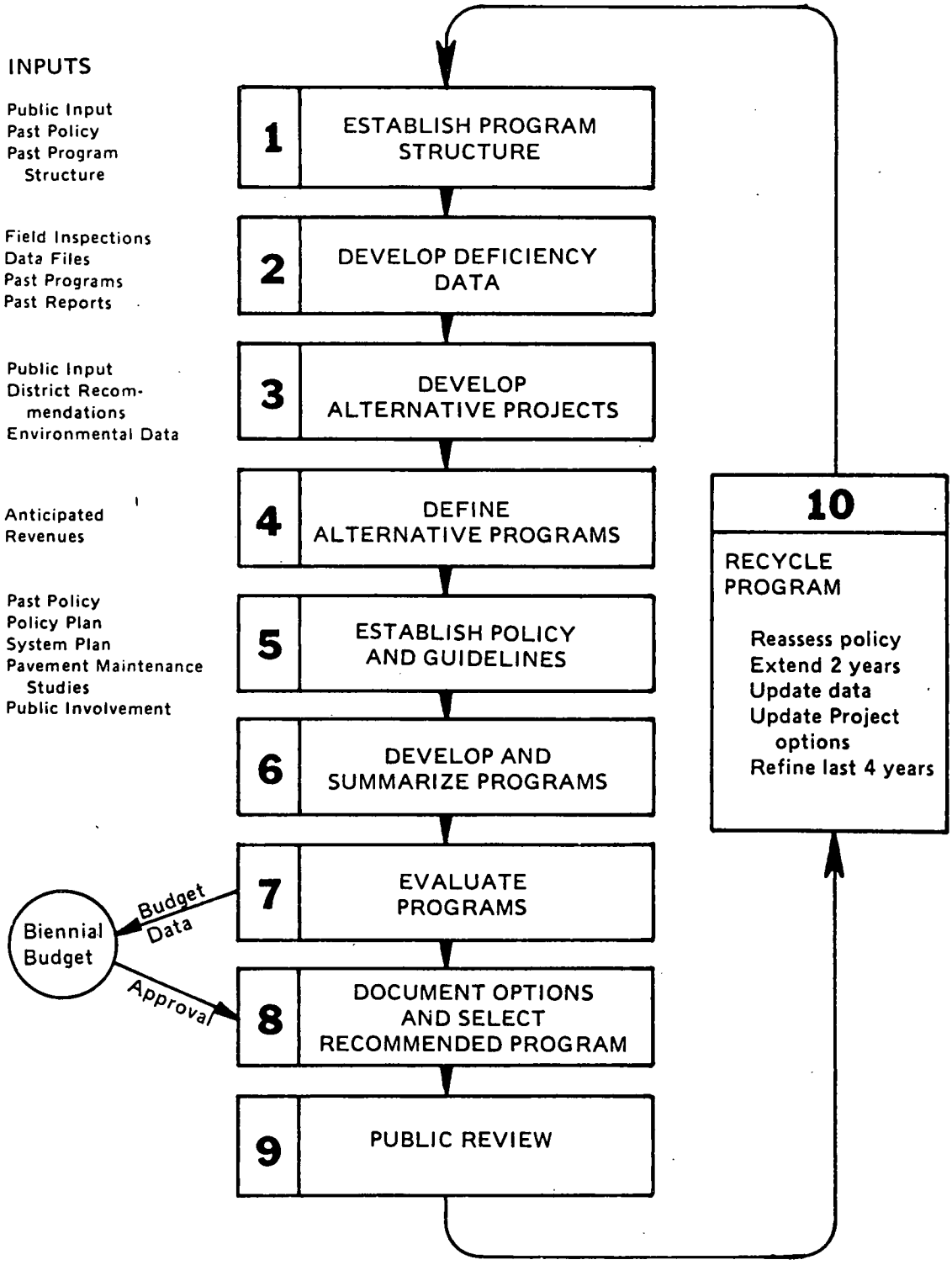

FIGURE A-14 Major steps of the programming process (Wisconsin) (*35*).

ability index (PSI) was used to measure surface condition. By varying the assumptions about the desired (or acceptable) level of surface quality (the PSI level), either statewide or by various classifications (e.g., functional class, ADT class, etc.), a range of surface renewal costs could be developed (*35*).

Interstate. The most recent interstate cost estimate was used.

Bridges. The FHWA sufficiency rating formula was used along with the state's own priority listing based on (a) load carrying capacity, (b) overall structural condition, and (c) geometrics (clearance, safety of approaches, etc.).

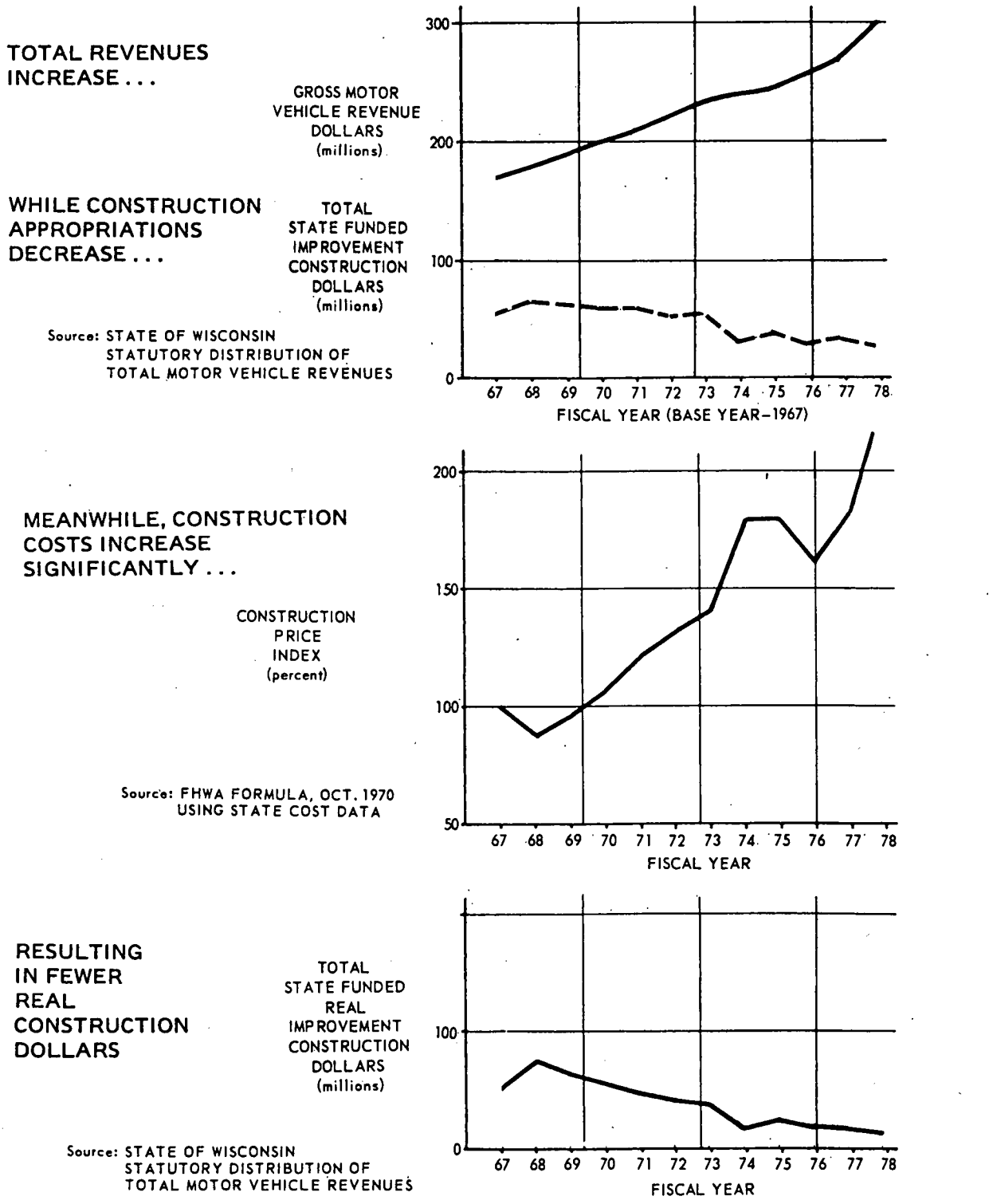

FIGURE A-15 Highway cost and revenue trends (Wisconsin) (*35*).

Major Projects. From a list of more than 100 potential projects, about 40 or 50 appeared to be realistic candidates. Of these, 30 projects were selected for a formal benefit-cost analysis using FHWA's highway investment analysis package (HIAP). In addition to the benefit-cost analysis, the same deficiency data (criteria) used to screen the STH system were also used to evaluate these projects.

Identify Deficiencies

Using the data collected on 6,000 miles (9 600 km) of state highway (the most critical half of the system), a computer information system produced summaries of the extent and severity of the various deficiencies statewide, by district and for each functional classification. The district

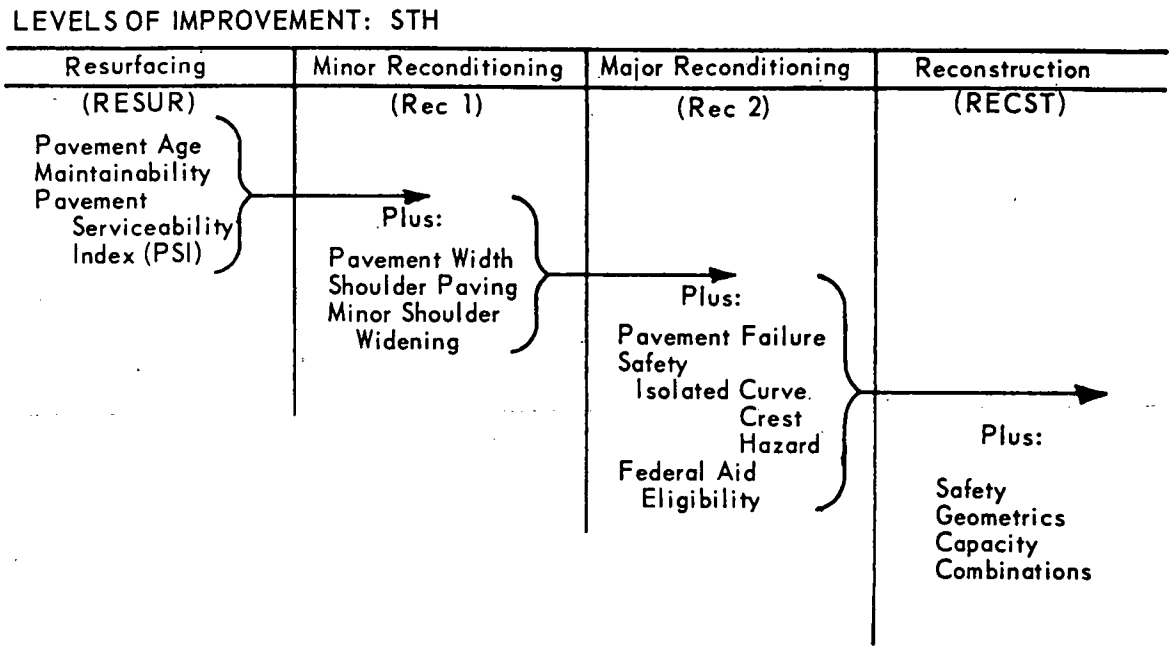

FIGURE A-16 Requirements for programming various levels of improvements (Wisconsin) (*35*).

offices analyzed the deficiencies on the STH. The central office analyzed bridges and interstate and major projects, using the criteria described previously. However, there was an iterative process by the districts and the central office that was used to reach agreement on the program.

Establish Project Priorities

RRR. District offices were given wide latitude in selecting projects for three funding levels (i.e., low, medium, and high, as discussed in the following section). The following criteria were used in establishing priorities:

- Minimum improvements needed to keep the STH system open and operating at varying levels of surface quality (the PSI analysis). This included both maintenance (resurfacing and minor reconditioning) and traffic operation.
- Reconstruction for higher-level improvements.

Specific criteria such as accident rates above specific levels, minimum design standards, etc., were not imposed upon the districts. However, to ensure consistency on a statewide basis in the level of improvement of proposed projects, district programming recommendations were required to reflect the rationale shown in Figure A-16.

Bridges. Priorities were set in the central office based on load-carrying capacity, posted limits, overall structural condition, geometrics, age, and traffic levels.

Interstate Projects. Priority was given to completion of the interstate system and selected operational and safety improvements on the existing facilities.

Major Projects. The benefit-cost analysis of HIAP was used in establishing priorities. Projects were grouped in priority categories, depending on whether work had been initiated, what strong commitments had previously been made, and the extent and severity of major deficiencies.

Develop Funding Program Packages

The alternative 6-yr program levels examined in each of the four program areas appear in Table A-4. These options

TABLE A-4
SUMMARY OF PROGRAM CHOICES (WISCONSIN) (millions of 1980 dollars) (*35*)

Program Area	Alternative	1979-1981 Biennial Budget	1979-1985 Highway Program
RRR Projects	Low	—	210
	Mid (Recommended and Approved)	130	370
	High	—	460
Major Projects	Low	—	160
	Approved	138	270
	Mid (Recommended)	215	370
	High	—	410
Bridges (non-major)	Low (Recommended and Approved)	28	85
	Mid	—	130
	High	—	175
Interstate (non-major)	Low (Recommended and Approved)	29	145
	Mid	—	195
	High	—	230

are the building blocks used to formulate the department's alternative overall highway program and eventually to choose a final program.

The department selected a recommended program from the range of alternatives shown in Table A-4. Thus a funding level was recommended for each of those four program areas. However, every 2 yr the governor must recommend and the legislature must approve a transportation budget, which determines the amount of money to be spent on highways during the most current biennium (the first 2 yr of the 6-yr program period). If a budget is approved with a rate of funding different from all the alternatives considered by the department, then in effect the legislature defines an additional program option.

Funding provided by the legislature for the biennium is labeled the approved budget, which, if projected through the 6-yr program period, results in what is termed the approved program. Obviously the accomplishment of either the recommended or approved six-yr program is dependent on the funding provided in the two subsequent biennial budgets. The following definitions are used:

Recommended Program. The six-yr program level recommended by the department.

Recommended Budget. The 1979–1981 biennial budget proposed by the governor, which is consistent with the recommended program and funds of the first 2 yr of the program.

Approved Budget. The budget level approved by the legislature for the 1979–1981 biennium.

Approved Program. The 6-yr program consistent with the 2-yr approved budget, which is the result of projecting the 2-yr biennial budget levels for the full 6-yr program period.

As is shown in Table A-4, the department's recommended and the legislature's approved programs are identical in all program areas except the major projects. The legislature's approved 1979–1981 biennial budget provides a funding level of $138 million for major projects, which is below the level of $215 million as recommended by the department and the governor. The legislature endorsed the list of major projects that the department proposed to address in the 1979–1981 biennium and beyond; however, the lower level of funding provided will slow the rate at which projects underway can be finished and new projects begun. If the budgeted funding level is extended over the 6-yr period and adjusted to exclude projects specially funded in the last 4 yr of this period, only the approved major project program, which totals $270 million, could be accomplished. To compensate for the difference between the approved 1979–1981 budget and the level recommended by the department and the governor and to get back on the track to accomplish the recommended program, the legislature will have to raise the funding for the nonspecially funded major projects by about $50 million for each of the next two bienniums.

Figure A-17 presents the overall program options considered by the department. The building blocks used to form the department's recommended overall program consist of the recommended programs in the RRR, major, interstate, and bridge program areas; the total cost for 6 yr is $970 million. An approved overall program totals $870 million for 6 yr and is composed of the same building blocks as the recommended overall program, except it includes the $270 million approved program for major projects instead of the $370 million recommended major project program. The department considered four additional overall programs as alternatives—a low $600 million option, a high $1.275 billion option, and two mid-level programs at $800 and $970 million—to illustrate possible tradeoffs within a midrange funding level.

Figure A-17 shows that many tradeoffs are possible at the $970 million level. For example, less money can be spent on major projects and more on projects in the RRR area or, conversely, the opposite can be implemented. Bridge work can be emphasized at the expense of work on RRR or interstate projects. The kinds of tradeoffs illustrated at the recommended $970 million level are also possible at the approved and high levels. However, such tradeoffs are not available to the same extent at the low overall program level due to greater proportional reliance on federal aid and correspondingly less flexibility in the use of state funds.

For the 1979–1981 biennium, the governor and legislature augmented the traditional sources of revenue by shifting $63.5 million from general program revenues. Of this amount, only $31.5 million was allocated to highway improvements. The department plans to recommend to the governor and legislature a longer-term solution to the highway financing problem before the next biennial budget deliberations.

Summary of Program Choices and Tradeoffs

Program alternatives have been described and evaluated in order to estimate the benefits and costs of programs at various funding levels in each of the RRR, Major Project, Bridge and Interstate Program areas. The program evaluations illustrate the tradeoffs within and between program areas. The results of this evaluation have guided the department in determining the recommended level of funding for highway improvements and the division of funds among various program areas. A description of key program tradeoffs is presented below:

1. *Tradeoffs Within Program Areas*

RRR Program Area. Three 6-yr program alternatives were considered in the RRR program area: (a) $210 million low program, (b) $370 million recommended program, and (c) $460 million high program. A basic issue at all levels of funding is what should be the mix among resurfacing, reconditioning, and reconstruction projects, and thus how much emphasis should be placed on lower types of improvements that result in more miles of surface renewal or higher types of projects that renew fewer miles of surface but last longer and address additional deficiencies (structural, safety, geometric, or capacity). The proper combination of projects depends on what objectives are being pursued, the available funding, and the costs and

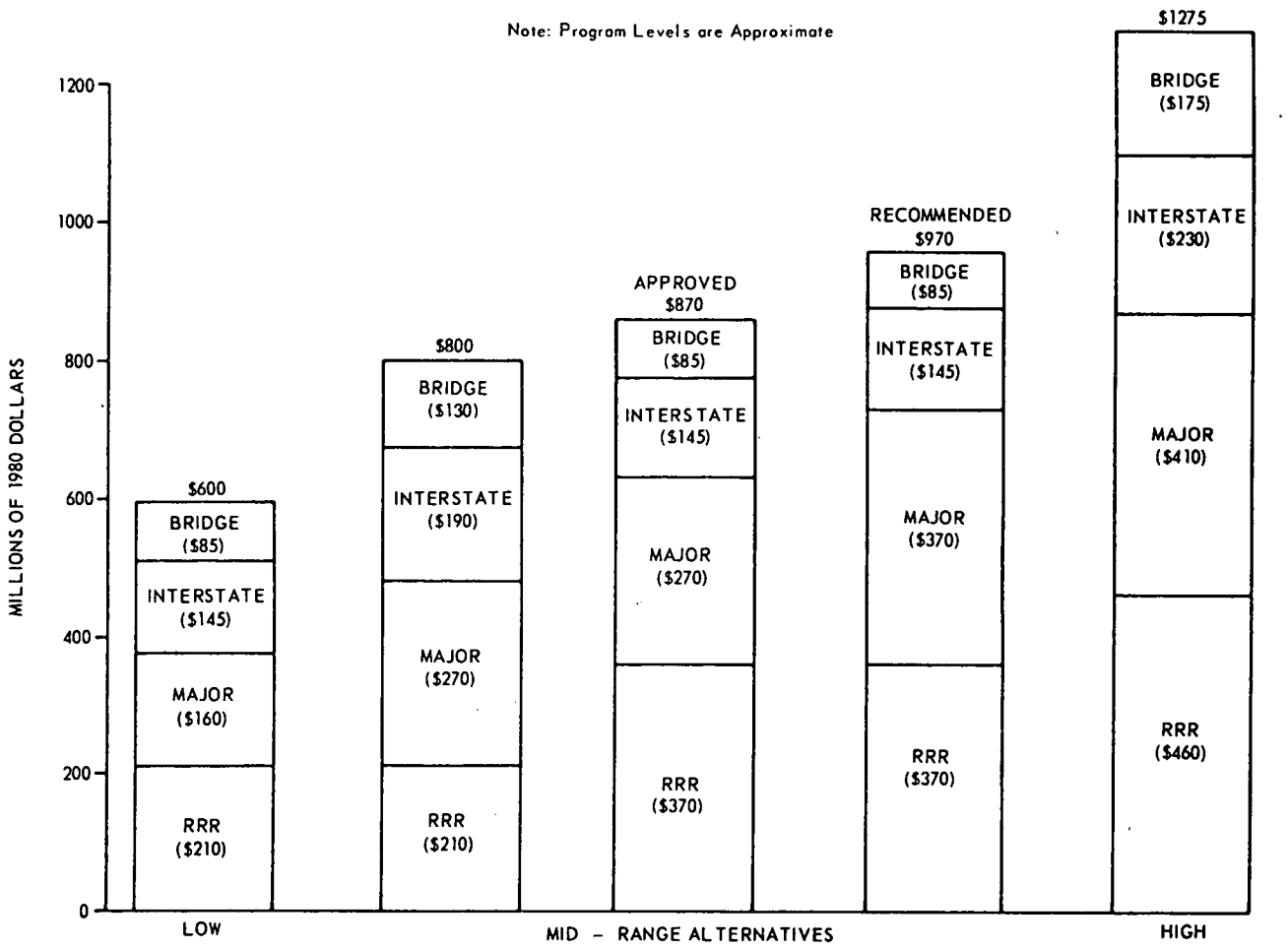

FIGURE A-17 Alternative 6-yr overall programs (Wisconsin) (*35*). (Program levels are approximate.)

benefits (economic and noneconomic) of each type of project.

At any particular funding level there is a tradeoff concerning the extent to which deficient pavement conditions versus other types of deficiencies (structural, safety, geometric, and capacity) can be addressed. However, there are some exceptions where the level of effort devoted to addressing certain deficiencies is likely to be the same regardless of the program considered. There may be a tradeoff between maintaining the ridability of the system in the short run and making the STH system easier to maintain in the long run. In the short run, there will be pavement deterioration unless sufficient surface renewal occurs, although erosion of pavement conditions can be partly stemmed by greater patching and maintenance resurfacing. In the long run, an emphasis on surface renewal may imply a shorter average project life and greater need for further surface renewal or other work in future years, whereas an emphasis on higher types of projects (major recondition and reconstruction) means longer durability and may imply an eventual need for less miles of surface renewal yearly. WisDOT currently does not have the data to rigorously establish the relationship between long- and short-run surface renewal needs.

Although there is a core level of maintenance work consisting of patching and intermittent maintenance resurfacing performed each year, the maintenance resurfacing work is a function of the nature of the improvement program. More surface renewal work and less higher-type improvements typically lead to a lower level of effort for maintenance resurfacing. However, if improvement dollars are concentrated on fewer miles of reconditioning and reconstruction (assuming a constant dollar constraint), then more maintenance resurfacing work will be needed.

There is a tradeoff between maximizing federal aid and meeting surface renewal mileage objectives. Although not explicitly confirmed in this programming effort, it is clear that a program that accomplishes only minimal surface renewal work could probably be found at a funding level below the low-program level. At such a level it would be impossible to both renew 2,100 miles of pavement and maximize federal aid at the same time, because many resurfacing projects would not qualify for federal aid. However, a program funded at the recommended level can simultaneously achieve surface renewal goals and capture all available federal funding.

Given the current scarcity of revenues it would be unwise (in the department's judgment) to forego some

federal assistance in order to achieve the surface renewal objective. However, to avoid being limited mainly to high types of improvements in selected areas, it is still necessary to maintain some state funding flexibility in order to improve certain roads that cannot practically be improved to federal standards (for example, because of substandard geometrics, commercial development close to highways, etc.) and as a contingency for unexpected cost increases. From the viewpoint of state financing there is a choice either to forego federal funding and make up the balance with state funds or to provide state funding to match federal dollars plus provide some extra state dollars to provide flexibility in implementing some projects. Because the federal government is willing to bear the larger portion of the costs of improving many highways, it is generally more beneficial to capture as much federal aid as possible, because it permits the state to develop a higher level of quality and durability for its highway system at the same level of state funding.

Other tradeoffs within the RRR program area are evident. These include (a) choosing to focus either on surface renewal projects that have mainly short-term and direct social, economic, and environmental impacts or on projects that in addition have longer-term impacts and sizeable secondary effects, and (b) whether to make or avoid improvements that could cause traffic to shift to highways.

Major Project Program Area. Alternatives for the major project program area were derived from (a) projects under construction, (b) high-priority projects in heavily traveled corridors where past investments have been substantial, (c) projects eligible for special federal funds, and (d) other projects that are candidates for construction and right-of-way acquisition.

The projects under construction and the two major bridges funded with federal-aid discretionary funds are estimated to cost nearly $160 million. This funding cannot be reasonably applied to other projects. However, at higher levels of funding there is considerable freedom to choose one project over another, with the exception of those that are eligible to receive special categories of federal funding. If the department desires to make maximum use of federal funding, major bridge projects eligible for discretionary funding should receive high priority.

The choices concerning the funding of other major projects involve (a) where to concentrate the benefits and costs of projects geographically; (b) whether to emphasize major bridge, high-cost interstate improvements funded 90 percent by federal funds, or other major projects on the STH system funded at matching ratios less favorable to the state; (c) whether to improve accessibility primarily on north-south or on east-west routes; (d) whether to improve highways in corridors where nonhighway modes are competitive or to improve highways elsewhere; and (e) whether to promote high or low levels of social, economic, and environmental impacts.

Interstate Project Program Area. All program levels considered for the interstate project program area would include funding for interstate resurfacing, restoration, and rehabilitation in addition to much needed bridge deck overlay work. These projects are necessary to maintain the existing interstate system, and therefore no choice is involved concerning this basic level of work, estimated to cost about $65 million. However, choices and tradeoffs are evident at levels of interstate funding above this $65 million.

Major capacity expansion has been excluded from the interstate program area, so that the basic issue is the allocation of extra program dollars either to (a) physically preserving the existing system; (b) improving the efficiency of the existing interstate system by transportation system management actions (ramp metering and park-and-ride); (c) improving safety (removing roadside obstacles, selective lighting, fencing, rest areas, etc.); or (d) improving the local environment near the interstate (noise barriers).

Bridge Program Area. Given the department's policy to maximize federal aid when reasonable, and given that the most seriously deficient bridges are to be replaced first, there are few meaningful choices within this program area. At higher bridge program levels the department would have some discretion concerning what types of bridge deficiencies to address: structural, geometric, or general condition. However, levels of state funding for bridges above what is necessary to maximize federal aid may be unwise. As stated earlier, considerable federal funding for bridge replacement is likely to be made available as large numbers of bridges throughout the nation become due for replacement, so there is little point in using scarce state funds to address a problem that eventually can be addressed with federal dollars.

2. *Tradeoffs Between Program Areas*

The possible tradeoffs between program areas are limited due to separate federal funding categories for the interstate and the bridge program areas. Essentially there cannot be tradeoffs between these two areas, except in the allocation of state money that is used to match the federal aid. If this state money is not used to match federal aid, the department has discretion over the use of state dollars. Also, funding cannot be reallocated from interstate or bridge work to RRR or major projects without losing federal funding. However, the state could choose to take money from the RRR or major project program areas and perform additional interstate or bridge work.

Despite some flexibility in the levels of interstate and bridge work funded, the fundamental tradeoff between program areas is between RRR and major projects. The more money devoted to major projects, the less reconstruction, reconditioning, and resurfacing can be accomplished on the STH system.

Table A-5 summarizes the alternatives considered in each program area. Although many other program options are available, the alternatives presented provide a good indication of the tradeoffs available within and between program areas at different levels of funding.

The tradeoffs between program areas assume there is a fixed level of funding for the overall state highway pro-

TABLE A-5
SUMMARY OF 6-YR PROGRAM OPTIONS (WISCONSIN) (millions of 1980 dollars) (*35*)

Program Level	RRR Program Area		Major		Bridge[1]		Interstate[2]	
	Program Level	Key Program Elements	Program Level	Key Program Elements	Program Level	Key Program Elements	Program Level	Key Program Elements
LOW	$210	-surface renewal of 1,551 miles does not meet target of 2,100 miles OR federal aid eligibility lost -some minor structural and safety reconditioning and reconstruction work	$160	-work toward completion of projects under construction including I-43 -2 federal aid discretionary funded bridges	$ 85 (recommended)	-replaces 174 bridges -over half of the posted bridges -selected low load capacity bridges -selected poor structural bridges	$145 (recommended)	-high priority safety projects including median barriers (I-94) and bridge deck overlays to preserve existing system -freeway surveillance system in Milwaukee
MID	$370 (recommended)	-surface renewal target satisfied (2,242 miles vs. 2,100 miles) AND federal aid eligibility achieved -expansion of improvement levels over low level -some increase in the total mileage programmed	$270 (approved) - - - - - $370 (recommended)	-Low Level Plus: -continue work on three high priority projects in corridors where previous investments have been substantial -additional new major starts -Approved Level Plus: -I-90 3rd lanes -more funds available for additional candidate majors	$130	-replaces a total of 243 bridges -includes all bridges in Low Program -most remaining low load capacity bridges -other poor structural condition bridges	$195	-all elements of Low Program -selected park-ride, rest area, bridge fencing -removal of roadside obstacles, lighting -other miscellaneous safety
HIGH	$460	-surface renewal target exceeded (2,867 miles vs. 2,100 miles) and federal aid eligibility achieved -expansion of improvement levels -some increase in total mileage programmed	$410	-Mid Level (Recommended) Plus: -some acceleration of work included at Mid Level (Recommended) -additional new major starts	$175	-replaces a total of 315 bridges -includes all bridges in Mid Program -other poor structural condition bridges -selected functionally obsolete bridges narrow roadway, restricted clearance, poor alignment -selected marginal structural condition bridges likely to deteriorate in near term	$230	-all elements of Mid Program -selected interchange improvements I-94, I-794 -noise abatement -truck weigh stations, additional park-ride lots and expansion of lighting

1/ Does not include several high cost bridges requiring special funding. These are treated as candidate major projects.

2/ Does not include major interstate projects but does include interstate I-R Program.

gram. However, if additional state funding becomes available, beyond the $31.5 million general program revenue supplement provided for improvements in the approved biennial budget, there would be much more flexibility in using the extra revenue.

In the department's judgment, the low program in each area represents a barely minimal level of effort. In the RRR program area $210 million is the minimum necessary to meet federal-aid eligibility objectives. In the major project program area, the low-program level of $160 million does not include any expenditures for new major highway improvement projects. It only provides for the completion of projects already in progress and the start of construction of the Arrowhead Bridge at Superior for which special discretionary federal aid has been acquired. (The other special bridge project at Dubuque was started in 1979.) The Arrowhead Bridge would require an estimated $6 million in state funds.

If the total state funds available allowed only the low-program levels in the RRR, bridge, interstate, and major program areas to be funded, including completion of those major projects that are under construction or specially funded projects, the department would probably not recommend any shift in funds between program areas. As more funds become available above this level, the priority of funding would be as shown in Figure A-18. The first priority would be to increase funding in the RRR area. The low-program level in the RRR area provides very little flexibility to fund much more than resurfacing and minor reconditioning work. Even if predominantly surface renewal type work were funded at this level, some overall deterioration in system surface quality would be likely, because improvement concepts must be keyed to federal-aid eligibility.

The availability of federal bridge funds and the ability of the interstate program to increase the total federal funds obtained by the state (coupled with the existence of priority needs in both areas, particularly interstate rehabilitation) suggest that further increases in funding be split between bridges and interstate once the RRR area is increased to near the recommended level. In addition, some new major project starts might be initiated before the recommended-level program in the RRR area is reached. Any new major project starts would be in response to existing needs, a high level of public support, and long-standing commitments by the state to such projects.

As additional funds became available above the approved levels in each area, major project acceleration or new starts would probably be the highest priority for additional funding along with RRR and associated bridge work. The funding level in the RRR program area would probably approach the midway point between the mid- and the high-RRR programs before additional interstate or bridge work was recommended, because the number of priority needs in the RRR area and the ability to do some work funded only with state dollars would make this the most cost-effective option.

Naturally, as still higher levels of funding become available, particularly in the RRR area, more extensive improvements to a given section of highway will be possible. Although these more extensive projects offer larger potential transportation and economic benefits, preconstruction project development activities are also more extensive and time-consuming and will represent more of a long-term program commitment than smaller improvements (e.g., resurfacing). In addition, these high-type projects are more likely to have some adverse social and environmental impacts that must be mitigated to ensure broad program support and acceptability.

3. *Social, Economic and Environmental Impacts—Tradeoffs*

Differing expenditures in the RRR, interstate, bridge, and major project program areas will have markedly different social, economic, and environmental impacts as shown in Table A-6. Beneficial and adverse impacts will usually be roughly proportional to the cost per mile of improvement projects, although making no improvements will also have adverse consequences. Funding at lower levels will result both in short-term adverse impacts due to construction, such as erosion, siltation of streams, and disruption of businesses, and in long-run benefits, such as preservation of an adequate system, improved driver comfort, and minor reductions in motor vehicle operation costs and fuel consumption. If only surface-renewal work is performed and nothing is done to improve capacity, congestion will increase as traffic grows. As a result there may be increases in air and noise pollution in selected areas. However, if current shortages of energy force the public to curtail travel, the historical pattern of increased travel from year to year may not continue.

Higher funding levels will have more severe short-term construction impacts as well as more significant longer-term impacts, such as the taking of homes, farmland, and wetlands. Higher types of improvement projects will improve accessibility and driving comfort, increase user benefits, such as time savings and accident reductions, and in some instances encourage more transportation activity. Projects that are short in length and do not significantly reduce congestion or travel time can be expected to have insignificant social, economic, and environmental impacts. Major projects involving lengthy segments of urban or rural highways are more likely to induce travel, economic, and development activity and associated environmental harm. Highway improvements may result in simultaneous accomplishment of social, economic, and environmental goals, or may require tradeoffs among these issues.

Other Modes

The Wisconsin DOT has the program responsibility for other modes of transportation as well as highways. However, the same thorough and systematic process of developing longer-term funding packages for air, transit, rail, and waterway projects has not yet been carried out. Wisconsin DOT officials plan to initiate these same procedures in analyzing the needs of the other modes in the near future.

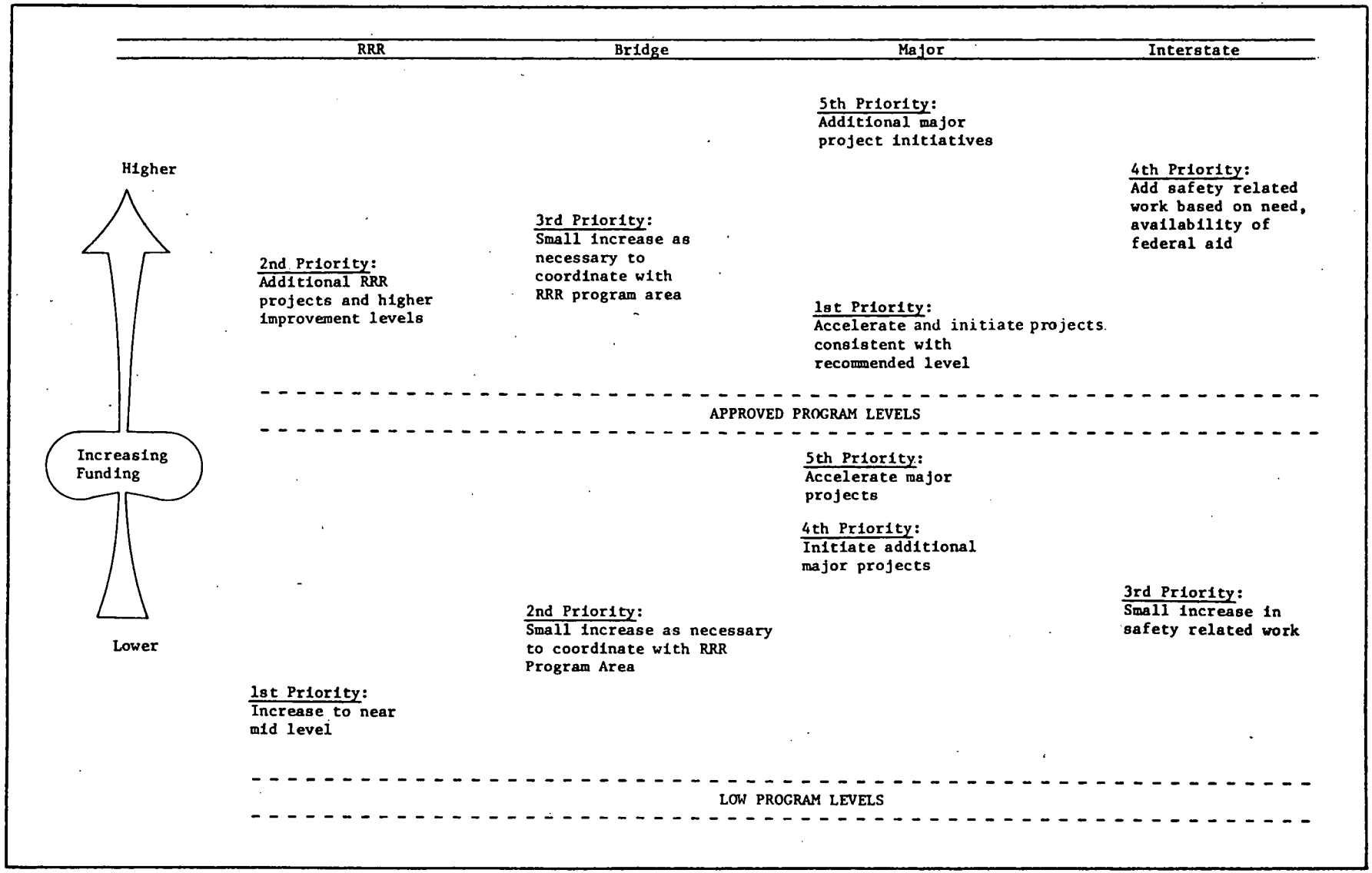

FIGURE A-18 Recommended program choices assuming increments of funding (Wisconsin) (*35*).

TABLE A-6
SUMMARY OF SOCIAL, ECONOMIC, AND ENVIRONMENTAL IMPACTS BY PROGRAM AREA AND FUNDING LEVEL (1980–1985) (WISCONSIN) (*35*)

Program	RRR Program Area		Major Projects		Bridge		Interstate	
	Program Level	Impacts	Program Level	Impacts	Program Level	Impacts	Program Level	Impacts
LOW	$210	-5,836-6,252 jobs* generated -26 businesses and 74 households displaced -1,510 acres of farmland taken and 38 farms severed -570 acres of habitat and 146 acres of wetland encroached upon -only 4 projects increase CO pollution -2.3-4.9 trillion BTU's of energy in materials and construction -14 highly controversial projects	$160	-4,500-4,800 jobs generated -8 businesses and 45 households displaced -1,468 acres of farmland taken and 53 farms severed -363 acres of habitat and 10 acres of wetland -4 new air and noise pollution sources -improved accessibility and secondary impacts; Index = 101 -3 highly controversial projects -3.4-5.1 trillion BTU's of energy in materials and construction	$ 85 (Recommended)	-2,250-2,400 jobs generated -174 bridge replacement projects will temporarily increase turbidity and siltation in some streams and cause noise and air pollution during construction -replacing half of posted bridges will reduce length of truck routes and save energy	$145	-4,200-4,500 jobs generated -energy consumed in materials and construction of safety projects -bridge deck replacement preserves structures; negligible disturbance to water quality -freeway surveillance system adds capacity without highway lanes and thus avoids taking homes and businesses plus reduces fuel consumption and pollution
MID	$370 (Recommended	-10,325-11,060 jobs generated -44 businesses and 100 households displaced 1946 acres of farmland taken and 48 farms severed -1150 acres of habitat and 186 acres of wetland encroached upon -only 6 projects increase CO pollution -3.4-8.5 trillion BTU's of energy in materials and construction -18 highly controversial projects	$270 (Approved)	-7,600-8,100 jobs generated -23 businesses & 98 households displaced -1,510 acres of farmland taken & 54 farms severed -743 acres of habitat and 70 acres of wetland -6 new sources of air and noise pollution -improved accessibility & secondary impacts: Index = 432 -4 highly controversial projects -4.7-7.0 trillion BTU's of energy in materials and construction	$130	-3,570-3,820 jobs generated -243 bridge replacement projects will temporarily increase turbidity and siltation in some streams and cause air and noise pollution during construction -replacing nearly all posted bridges will reduce length of truck routes and save energy	$195	-5,470-5,860 jobs generated -all impacts of low program -increased localized pollution at park-ride lots; reduces congestion, pollution and energy consumption in corridor served by transit -added lighting increases energy consumption and air pollution at power plants
HIGH	$460	-not available	$410	-11,500-12,300 jobs generated -35-89 businesses and 133-288 households displaced -2,373-4,308 acres of farmland taken and 78-134 farms severed -1,019-1,891 acres of habitat and 78-134 acres of wetland -6-12 new sources of air & noise pollution -improved accessibility and secondary impacts: Index = 543-926 -5-8 highly controversial projects -8.2-12.2 trillion BTU's of energy in materials and construction	$175	-4,900-5,250 jobs generated -315 bridge replacement projects will temporarily increase turbidity and siltation in some streams and cause air and noise pollution during construction -replacing nearly all posted bridges will reduce length of truck routes and save energy	$230 (Recommended)	-6,450-6,900 jobs generated -all impacts of Mid Program -selected interchange improvements improve accessibility and create construction noise and air pollution -noise reduction with adverse aesthetic impacts -new weigh stations help reduce overweight trucks but create localized air and noise pollution

* All estimates of jobs generated are in units of person-years of work.

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