NATIONAL COOPERATIVE
HIGHWAY RESEARCH PROGRAM REPORT **283**

TRAINING AID FOR APPLYING NCHRP REPORT 263

SIMPLIFIED PROCEDURES FOR EVALUATING LOW-COST TSM PROJECTS

TRANSPORTATION RESEARCH BOARD
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SIMPLIFIED PROCEDURES FOR EVALUATING LOW-COST TSM PROJECTS

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AREAS OF INTEREST:

PLANNING
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TRANSPORTATION RESEARCH BOARD
NATIONAL RESEARCH COUNCIL
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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 communications and cooperation with federal, state, and local governmental agencies, universities, and industry; its relationship to the National Research Council 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.

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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.

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FOREWORD

By Staff
Transportation
Research Board

Transportation planners, traffic engineers, and transit operators will find this workbook, or Programmed Learning Text (PLT), a useful tool for understanding and applying *NCHRP Report 263,* "Simplified Procedures for Evaluating Low-Cost TSM Projects—User's Manual." *NCHRP Report 263,* published by the Transportation Research Board in 1983, represents a comprehensive compilation of the best available technology for planning and implementing Transportation System Management (TSM) actions. This PLT serves those desiring hands-on experience with *NCHRP Report 263* as a comprehensive and an orderly tutorial that permits the user to proceed at a comfortable pace through a series of logical steps starting with the identification and definition of a problem and proceeding through an increasingly detailed process of elimination and refinement of candidate actions until a workable solution is chosen.

NCHRP Report 263 documents a practical, problem-oriented approach to identifying, developing, evaluating, and programming TSM actions. Its tables, guidelines, and information summaries are intended to assist agencies in applying the approach to identify feasible, workable, and low-cost solutions to near-term problems in their communities. Analysis procedures are included to help agencies develop potential solutions into packages ready for programming and implementation. Sample applications and case studies are included to illustrate the use of these analysis procedures.

NCHRP Report 263 is the final report on the first phase of NCHRP Project 7-11. In the second phase (Project 7-11A), material was developed for disseminating and promoting the use of the TSM material presented in *NCHRP Report 263,* primarily to technical staffs of States, metropolitan planning organizations, and local governments. This PLT is the major product of Project 7-11A. It is also the focal point of three other products developed in Project 7-11A: (1) an audiovisual presentation consisting of six Slide/Tape Modules, (2) a four-disc interactive Computer Assisted Instruction (CAI) Program for IBM-PC compatible computers, and (3) a 5-minute Slide/Tape Module titled: "TSM for Elected Officials," describing the TSM concept for a nontechnical audience. All of these training aids follow the format used in *NCHRP Report 263* to develop the recipient's familiarity with the User's Manual.

Copies of *NCHRP Report 263* are available for purchase at a cost of $12.80 upon written request to the Publications Office, Transportation Research Board, 2101 Constitution Avenue, N.W., Washington, D.C. 20418. Copies of the audiovisual presentation and the CAI supplement are available on a loan basis from the Federal Highway Administration, Planning Analysis Division, HPN-23, 400 7th Street, S.W., Washington, D.C. 20590 (these copies are reproducible).

CONTENTS

ACKNOWLEDGMENTS

This training aid was prepared by the Texas Transportation Institute (TTI), Texas A&M University System, as partial fulfillment of NCHRP Project 7-11 Continuation entitled "Low-Cost TSM Projects—Simplified Procedures for Evaluation, Phase II." Dr. John M. Mason, Jr., Program Manager, Implementation and Design Program at TTI, served as Principal Investigator. Other principal authors of this publication included Dr. Joseph D. Blaschke, Assistant Research Engineer, and Mr. Duk M. Chang, Graduate Research Assistant.

TRAINING AID FOR APPLYING NCHRP REPORT 263

Simplified Procedures For Evaluating Low-Cost TSM Projects

SUMMARY

This training aid, hereinafter referred to as the Programmed Learning Text (PLT), is part of a coordinated series of user-oriented materials designed to assist in applying the principles and practices of *T*ransportation *S*ystems *M*anagement (TSM). The series of materials also include:

- Audiovisual presentations (6-Slide/Tape Modules).
- Interactive computer-assisted instruction (CAI) materials (Instruction Booklet and 3-CAI Modules).
- NCHRP Report 263 User's Manual as the cross-reference.

The PLT serves as the *focal point* of all the self-training aids; the slide/tape series and the CAI materials supplement the PLT. Because *NCHRP Report 263—User's Manual* is continually referred to, a copy of that report must be available.

This text was prepared primarily for engineers and planners engaged in TSM project planning and development. Even those individuals who do not consider themselves technically proficient (e.g., agency administrator, project manager, or general reader) will discover that the organized self-instructional format of the text is conducive to understanding TSM. Readers can proceed at their own pace, stopping as often and as long as desired until the material is understood. Questions are posed in short quizzes, and answers are provided to measure one's understanding of *NCHRP Report 263.*

The PLT contains seven primary sections:

- **Section I—Introduction** briefly discusses the fundamental concepts and benefits of TSM.
- **Section II—Key Terms** clearly defines some of the terms used in NCHRP Report 263 and demonstrates their applicability to TSM.
- **Section III—Summary of Reference Handbook** provides a summary of Part II of the Reference Handbook (*NCHRP Report 263*) to coordinate and assist in the application of the TSM planning framework. Practical guidelines are provided for ease of implementation. This section also summarizes the three primary "Aids" addressed in the Blue, Green, and Yellow sections of the Reference Handbook.
- **Section IV—Step-by-Step TSM Process** is the primary element of the PLT. The process consists of a series of nine logical steps that start with the identification of problems and proceed toward workable and acceptable TSM solutions. A cross-reference is provided to the pertinent pages of *NCHRP Report 263.* Short quizzes with questions and answers on the steps of the TSM process are included for the reader's self-evaluation.

- **Section V—Complete Example of the Step-by-Step Process** demonstrates the step-by-step TSM decision-making process using a typical TSM case study.
- **Section VI—Case Studies** reviews, examines, and explains the case studies included in *NCHRP Report 263* using the step-by-step process presented in Section IV.
- **Section VII—Answer Sheets to Questions** provides the answers to the quiz questions for Sections IV and VI.

There are six unique slide/tape modules:

- **Module I—Overview of TSM.** TSM concepts are introduced, and the components of *NCHRP Report 263* are briefly discussed by citing applied actions.
- **Module II—Simplified Procedures for Evaluating Low-Cost TSM Projects—User's Manual.** The three distinct parts of *NCHRP Report 263* are reviewed in detail to familiarize the user.
- **Module III—Self-Training Aids for NCHRP Report 263—User's Manual.** This module contains a brief presentation on the contents of the PLT, CAI, and the six-part slide/tape series.
- **Module IV—Step-by-Step TSM Process.** A nine-step process is described to facilitate identifying, evaluating, and implementing various TSM actions.
- **Module V—TSM Process in Action.** The nine-step process of Module IV is demonstrated through a comprehensive sample of a *corridor analysis* along an urban arterial street.
- **Module VI—The NCHRP Report 263 Case Studies.** The case studies included in *NCHRP Report 263* are presented and organized according to the nine-step TSM process.

The computer-assisted instruction (CAI) materials require an MS-DOS Operating System and are designed to increase the use of Part II in *NCHRP Report 263.* Three CAI modules include:

- **Module I**—A *Tutorial* on NCHRP Report 263.
- **Module II**—TSM *Action Screening Aids* to expedite the identification of pertinent actions without jeopardizing a comprehensive application/evaluation process.
- **Module III**—Analytical techniques, relevant reports, and selective notes for quick reference in the *selection and analysis* of screened TSM actions.

There is no prescribed order in which the self-instructional materials must be used. Several pilot reviews resulted in a preference to start with the PLT. This fortunately supported the intent of having the PLT serve as the focal documentation. Once familiar, the user can select from among the other supplemental aids.

When using the CAI, it is recommended that the *Computer Aided Instructions* booklet be reviewed first; the Tutorial, Screening Aids, and Analysis Techniques can follow.

Each slide/tape module is essentially a "stand-alone" presentation. Some repetition of information is inherent. First-time users may actually want to start with Module III—Self-Training Aids—and then review Modules I and II. In other situations, Module III could be used as a "train-the-trainer" unit. Modules IV, V, and VI are best understood if reviewed in numerical order. The slide/tape modules are adaptable and are not limited by geography, application, or purpose.

The entire package of self-instructional materials is flexible. These aids provide a hands-on experience with *NCHRP Report 263* and illustrate the effectiveness of carefully selected low-cost TSM actions.

SECTION I

INTRODUCTION

DEFINITION OF TSM

Transportation Systems Management (TSM) is the coordination of automobiles, trucks, public transit, taxis, pedestrians, and bicycles through operating, regulatory, and service policies so as to achieve maximum efficiency and productivity for the existing transportation facilities as a whole.

GOALS AND OBJECTIVES

Consistent with local transportation policies, TSM should have a comprehensive orientation. It should not only concern itself with operating and managing the existing transportation facilities in the most efficient fashion to meet mobility objectives, but also consider energy, air quality, economic efficiency, and environmental and community quality objectives. The list in Table I-1 is a comprehensive set of goals and related objectives for TSM strategies.

BENEFIT OF TSM

TSM places direct emphasis on practical, low-cost, and short-range planning and programming projects for implementing transportation improvements. Ideal TSM programs simultaneously increase mobility and reduce social costs by reducing vehicular demand and increasing roadway capacity and safety.

DIFFERENCES BETWEEN TSM AND LONG-RANGE PLANNING

TSM's action orientation and detailed information base make TSM planning fundamentally different from long-range planning. The process used for TSM planning should reflect these differences, which are summarized in Table I-2, and not mimic the comprehensive analysis process that has been developed for long-range planning.

Table I-1. A set of goals and objectives for TSM strategies.

GOALS	OBJECTIVES
Improve personal mobility	Improve level-of-service of urban travel Improve reliability of travel Provide attractive alternative to driving cars Provide transportation to elderly and handicapped Improve facilities for pedestrians and bicycles Improve responsiveness to changing needs
Improve public safety	Reduce occurrence of traffic accidents Reduce injuries and deaths Improve personal security of urban travelers
Enhance environmental and community quality of life	Reduce automotive emissions and impacts Reduce noise and vibration impacts Minimize adverse impacts on natural environment Minimize community disruption and relocation Enhance aesthetic qualities of urban environment Complement long-range urban land use goals
Conserve energy resources	Reduce fuel consumed in urban travel
Improve the economic efficiency of transportation	Increase capacity of existing facilities Reduce personal costs of urban travel Reduce public costs of urban systems Achieve greater equity in payments Reduce costs of urban goods movements Minimize adverse impacts caused by transportation Maximize positive economic impacts

Table I-2. Key differences between TSM and long-range planning.

ITEM	TSM	LONG-RANGE
Problems	Clearly defined, observable	Dependent on growth scenarios and projected travel
Scale	Usually local, subarea, or corridor	Usually corridor or regional
Objectives	Problem-related	Broad, policy-related
Options	Few specific actions	Several model, network, and alinement alternatives
Analysis Procedures	Usually analogy or simple operational relationships	Based on trip and network models
Response Time	Quick response	Not critical
Product	Designs for implementation	Alternatives for further study or detailed design

SECTION II

KEY TERMS

ACTION—Physical or operational change, or a specific site improvement.

CONDITION ANALYSIS—Any information that is needed to identify and develop effective solutions.

PACKAGE—A group of proposed actions to solve a specific set of problems.

PROGRAM—A list of specific actions and packages to be implemented during the next fiscal period(s), generally one or two years, supplemented with funding and scheduling information.

RECOMMENDATION—Alternative action plans that should consist of implementable designs and include schedules for staged implementation with anticipated project budgets.

SCREENING ACTIONS—Screening a candidate set of actions and strategies for applicability, feasibility, and effectiveness in a specific study area.

STRATEGIC MANAGEMENT—Activities that establish an agency's or community's needs, objectives, priorities, and programs.

STRATEGY—A general approach that can be taken to solve specific problems.

TACTICAL PLANNING—Project activities that develop detailed solutions to a specific set of problems.

WORKABLE SOLUTIONS—Acceptable solutions for implementation that lead to a recommended action plan.

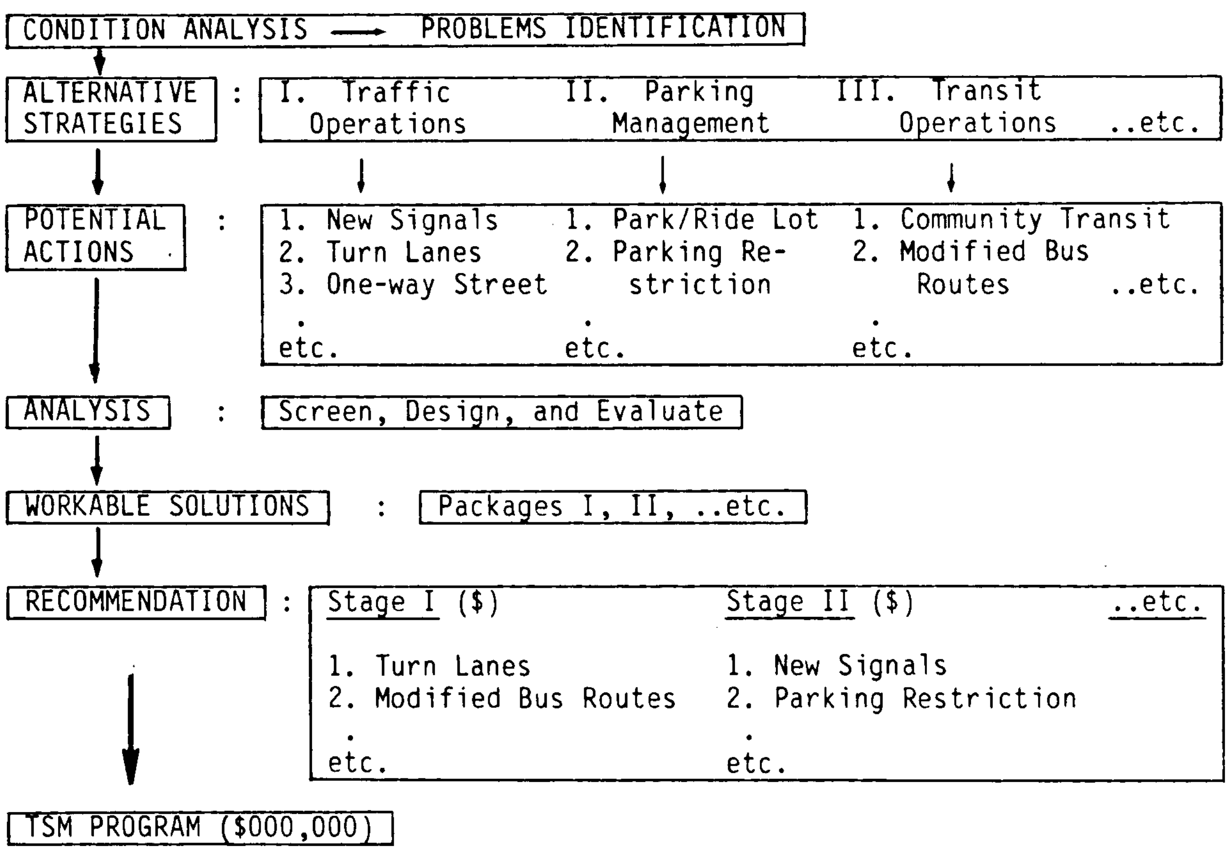


Figure II-1. Relationships among key words.

SECTION III

SUMMARY OF REFERENCE HANDBOOK—PART II of NCHRP Report 263

INTRODUCTION

NCHRP Report 263—User's Manual is divided into three sections identified as Parts I, II, and III. Part I consists of the Introduction and Procedural Guide for using the report. Part II, the color-coded sections of NCHRP Report 263, is the Reference Handbook portion of the report which aids the reader in screening potential TSM actions, analyzing the potential actions, and evaluating and estimating the impact of the actions. Part III presents the applications of TSM actions to six different examples or "case studies."

The main emphasis of this PLT is to assist the reader in understanding Part II of *NCHRP Report 263.* The remainder of this section summarizes Part II. The discussion under **A** describes the contents of the **Blue** portion of *NCHRP Report 263,* and the contents under **B** and **C** summarize the **Yellow** and **Green** portions, respectively.

PART II—NCHRP REPORT 263

A. Action Screening Aids (NCHRP Report 263, BLUE SECTION)

TSM is a broad concept covering a variety of physical, operational, regulatory, and managerial actions. TSM actions can be quickly and inexpensively designed and implemented to affect the use and performance of transportation facilities. Only a few of these actions are likely to be feasible means of solving any specific problem.

The **Blue** section in *NCHRP Report 263* contains six TSM Action Identification Tables that identify general approaches and types of TSM actions to consider in developing solutions to problems. The problems and potential TSM actions are listed under "scale or location categories." These six TSM **Action Identification Tables** are:

- Table 1—**Problems at Isolated Intersections or on Street Segments**
- Table 2—**Problems in Corridors**
- Table 3—**Problems in Residential Communities**
- Table 4—**Problems at Employment Centers**
- Table 5—**Problems at Commercial Centers**
- Table 6—**Regional, State, and National Problems**

The Action Identification Tables list under the first column several **"Underlying Transportation Deficiencies"** (e.g., insufficient capacity to handle peak traffic volumes at acceptable levels); under the second column, one or more **"Corrective Strategies"** to solve the problem (e.g., reduce travel delays through more effective use of existing capacity); and under the last three columns, **strategic "Actions"** that can be applied to solve or alleviate the problem (e.g., signal timing or phasing changes).

Many of these "Actions" (37 in number) are discussed thoroughly in separate **"Action Profiles,"** pages 59–112 of *NCHRP Report 263.* All of the actions contained in the Action Identification Tables are not included in the Action Profiles because the profiles emphasize local, suburban, and corridor actions; however, most actions not covered are similar in nature to some Action Profile. The Action Profiles provide the following information (examples are enclosed in parentheses):

1. A brief description (Flexible Working Hours).
2. A list of problems that are commonly addressed by the action (Traffic Congestion in Employment Centers During Peak Hours).
3. Transportation conditions and land use typically affected by the action (Slack Capacity of the Roadway System).
4. Issues that should be addressed before designing the action and possible problems that could result after the action is implemented (Cooperation of Businesses).
5. Evaluation factors that could be used for assessing the action (Congestion Reduction).
6. References to reports, manuals, or articles that provide additional information on the action's feasibility and effectiveness *(NCHRP Synthesis of Highway Practice 73).*

For easy reference, Table III-1 contains a list of the 37 TSM Action Profiles and their relationship to the six TSM action categories (or six TSM Action Identification Tables).

B. Impact Estimation and Analysis Aids (NCHRP Report 263, YELLOW SECTION)

The **Yellow** section of *NCHRP Report 263* consists of three parts:

1. A discussion on estimation and evaluation techniques.
2. Selection of aids to perform those techniques.
3. Simplified technical notes on those selected techniques.

The complete TSM project development process includes estimating the impact of a specific project on the roadway system and the local environment and evaluating the benefits to be derived from the project. The purpose of the yellow section of *NCHRP Report 263* is to provide the user guidelines for preparing an information base and selecting performance measures to efficiently and responsively analyze potential TSM actions and packages.

Table III-1. TSM action profiles.

ACTION PROFILES	LOCATION or SCALE "a"						
	1	2a	2b	3	4	5	6
1. Staggered Work Hours					*		
2. Flexible Working Hours					*		
3. Increased Peak Period Roadway, Bridge, or Tunnel Tolls			*				
4. Toll Discounts for Carpools During Peak Periods			*				
5. Residential Parking Permits				*			
6. Neighborhood Traffic Barriers				*			
7. Park-and-Ride Lots Along Transit Routes		*	*				
8. On-Street Parking Bans During Peak Periods	*	*			*		
9. Parking Reserved for Short-Term Use					*	*	
10. Increased Parking Rates					*		
11. Parking Rate, Fine, and Time Limit Adjustments				*	*	*	
12. Expanded Off-Street Parking					*	*	
13. Freeway Ramp Control			*				
14. Freeway Ramp Closure			*		*	*	
15. Travel on Freeway Shoulders During Peak Periods			*				
16. One-way Streets to Improve Flow		*			*	*	
17. One-way Streets to Impede Flow				*		*	
18. Reversible Lanes		*			*		
19. Two-way Left-Turn Lanes	*	*					
20. New Street Segments		*			*	*	
21. Signal Phases for Left Turns	*	*			*	*	
22. Reroute Turning Traffic	*	*			*	*	
23. Use of Fleet Vehicles for Carpooling					*		
24. Employer-Based Carpool Matching Programs					*		
25. Employer Vanpool Programs					*		
26. Freeway Lanes Reserved for Buses or Carpools			*				
27. Priority Freeway Access/Egress for Buses or Carpools			*		*		
28. Arterial Street Lanes Reserved for Express Buses or Carpools		*					
29. Shuttle Buses or Vans					*	*	
30. Circulation Buses or Vans					*	*	
31. Bus Transfer Stations		*	*			*	
32. Expanded Regular-Route Bus Service		*		*			
33. Limited and Skip-Stop Bus Routes		*					
34. Pedestrian-Only Streets						*	
35. Shared-Ride Taxi				*			*
36. Elderly/Handicapped Paratransit Service Brokerage							*
37. Community Transit Services				*			

"a" Notes:
- 1 - Isolated intersections or street segments.
- 2a - Arterial street corridors.
- 2b - Freeway corridors.
- 3 - Residential communities.
- 4 - Employment centers.
- 5 - Commercial centers.
- 6 - Regional.

Seven general types or categories of **estimation techniques** are addressed in *NCHRP Report 263.* While not intended as a rigid classification, these seven categories, described below with examples, have some basic distinguishing features:

1. **Specification**—set values and activity measures (15-min proposed bus headways, LOS "C" on an improvement).
2. **Direct measurement**—values of some measures directly from field surveys or maps (lane-miles, length of bus route).
3. **Direct calculation**—measures of interest (sums, products, ratios, costs, or financial measures).
4. **Analogy**—comparison of performance levels and impacts observed for an action implemented at other sites.
5. **Look-up**—performance and impact levels observed from implementing common actions, graphs, and tables (research study findings).
6. **Simple equations and formulas**—estimates of derived measures (population growth rates).
7. **Analytical or simulation models**—series of relationships, equations.

Additional discussion concerning different approaches to applying the estimation techniques (computerized vs. manual, level of detail, use of borrowed information, etc.) and factors that affect the application process (size of impact, ability to fine tune, etc.) can be found in the yellow section.

Method Selection Aids are contained on pages 117–141 of *NCHRP Report 263* to assist in setting up simple and efficient analysis plans and in selecting appropriate estimation techniques and application procedures. Selection aids are provided for the following seven general categories of **performance characteristics** or **impacts:**

- Aid 1—Estimating **Supply/Capacity**
- Aid 2—Estimating **Travel Time and User Cost**
- Aid 3—Estimating **Safety**
- Aid 4—Estimating **Travel Volume**
- Aid 5—Estimating **Finance**
- Aid 6—Estimating **Air Quality**
- Aid 7—Estimating **Energy Use**

Each aid contains helpful information, as described below with examples:

1. Specific characteristics or impacts (reduce delays).
2. Conditions under which estimation is required or desirable (verification that a time savings has been achieved).
3. Types of procedures (direct measurement of travel time).
4. Appropriate techniques detailed in each Method Selection Table (use curves relating speed to volume/capacity ratio for different types of roadways).
5. References for further information, including cross-references to Action Profiles (1–37) and Notes on Techniques (TN 1–11).

The **Technical Notes** on selected techniques are included in the yellow section, pages 142–164, to present example applications of the estimation techniques. Eleven unique examples are provided:

- Tech. Note 1—**Simplified Trip Distribution**
- Tech. Note 2—**Critical Accident Rate Factor**
- Tech. Note 3—**Speed-Volume Tables**
- Tech. Note 4—**Transit Supply Estimation Procedure**
- Tech. Note 5—**Transit Service and Fare Elasticities**
- Tech. Note 6—**Inflation and Escalation Indices**
- Tech. Note 7—**Accident Reduction Factors**
- Tech. Note 8—**Fuel Consumption Adjustment Factors**
- Tech. Note 9—**Emission Rate Adjustments**
- Tech. Note 10—**Critical Lane Analysis**
- Tech. Note 11—**Queue Length Analysis**

Each technical note (e.g., Simplified Trip Distribution) describes its purpose (e.g., estimate future trips for planning roadway improvements) and example applications (e.g., computations, charts, tables, and graphs).

C. Additional Planning and Evaluation Aids (NCHRP Report 263, GREEN SECTION)

The *NCHRP Report 263* **Green** section contains additional information to assist agencies in planning and programming TSM actions. This additional information consists of four **Notes on Evaluation and Packaging (E/P) Techniques.** The four Notes may be useful in certain aspects of some agencies' strategic management or project planning activities. These Notes are not intended to be used in *ALL* TSM projects; instead, they are for supplemental benefit to the TSM analyst.

E/P Note 1, **Problem Assessment Techniques,** addresses procedures available to assess the conditions of a facility or to determine a "performance rating." Factors considered include roadway geometrics, physical condition of the facility, signing, safety, functional classification, and traffic volumes. Transit-related assessment factors include productivity, service quality, cost recovery, average speed, and coverage of service area.

E/P Note 2, **Project Packaging Techniques,** discusses the importance of packaging TSM actions as part of the strategic management and project planning activities, using both quantitative and qualitative factors to produce logical combinations of actions. TSM "packaging" is useful in efficiently completing the following activities:

1. Assessing the problems.
2. Scoping the projects.
3. Recommending and scheduling (coordinating) the implementation of selected projects.

E/P Note 3, **Cost-Effectiveness and Benefit/Cost Analysis,** describes techniques for making quantitative comparisons between potential projects, evaluating alternative designs, and allocating funds among selected projects. **Cost/effectiveness analysis** uses ratios of individual effectiveness (or performance measures) to costs to evaluate and compare projects (e.g., accidents eliminated per dollar invested or hours of delay saved per dollar invested). **Benefit/cost analysis** provides the means of combining and weighing different types of measures by assigning them monetary values (e.g., value of time savings and value of avoiding an injury).

E/P Note 4, **Program Development Techniques,** defines sufficiency ratings (called **priority arraying**) that incorporate roadway network importance, public costs, user benefits, and social/environmental factors in evaluating and ranking new construction and major improvement projects. Generally, this process targets low-cost projects that provide significant benefits (high benefits/cost ratio).

TSM Information Sources on pages 178–181 of NCHRP Report 263 include a list of publications in a "Basic Reference Library" under the following categories: General, Traffic and Parking, Transit/Paratransit, Computer Ridesharing, Elderly and Handicapped Transportation, Pedestrians, and Goods Movement.

A list of **Agency Information Offices** where TSM publications may be obtained includes several offices within the U.S. Department of Transportation and other organizations.

SECTION IV

STEP-BY-STEP TSM PROCESS

Strategic management activities set up a policy framework. They identify the problems, the resources (e.g., available funds and any restrictions), guidelines, and standards. With the establishment of realistic strategic guidelines, tactical planning can be conducted to identify and develop TSM activities that are ready for implementation as an engineering, operations, or design effort. In *NCHRP Report 263,* the **tactical planning activities** are grouped into four distinct phases with certain tasks:

- Phase 1—**Analyze Problems and Their Setting**
  - Assemble and review information
  - Analyze conditions
- Phase 2—**Identify and Screen Candidate Solutions**
  - Identify actions
  - Screen actions
  - Specify initial packages
- Phase 3—**Design, Analyze, and Evaluate Solutions**
  - Plan the analysis
  - Evaluate performances of solutions
  - Analyze side impacts
- Phase 4—**Recommend an Action Plan**

Within Phases 1, 2, and 3, specific steps are identified as tasks necessary to accomplish the objectives of the individual goals of each phase. (Phase 4 is essentially a specific step.) Based on the four phases, nine individual steps are listed to provide an orderly planning process for identifying and developing effective TSM activities. This section of the PLT describes in detail each individual step, encourages the reader to use the step-by-step process when developing TSM activities, and explains the benefits of using *NCHRP Report 263* as a reference book for accomplishing the requirements of the nine-step process.

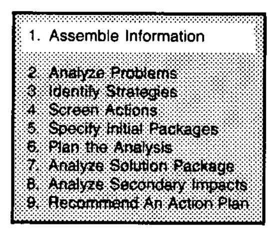
The nine-step tactical planning process assists the analyst in determining the problems to be addressed, identifying the resources available for implementing solutions, and selecting the guidelines and standards to apply in designing and evaluating solutions. The process involves a sequence of increasingly detailed, yet simplistic, decisions that ultimately result in a workable solution to the original problem.

The nine-step process, listed below, *should not be viewed as a rigid process.* It can be modified as desired to meet the needs of specific applications, even omitting some steps in certain situations. The primary purpose of the process is to provide an orderly arrangement of decision-making actions to accomplish the goals and objectives of TSM.

- Step 1—**Assemble and Review Information**
- Step 2—**Analyze Problems and Their Setting**
- Step 3—**Identify Candidate Strategies and Actions**
- Step 4—**Screen Actions for Applicability and Effectiveness**
- Step 5—**Specify Initial Packages for Analysis**
- Step 6—**Plan the Analysis**
- Step 7—**Analyze Performance of Solution Packages**
- Step 8—**Analyze Secondary Impacts of Solution Packages**
- Step 9—**Recommend an Action Plan**

STEP 1. ASSEMBLE AND REVIEW INFORMATION

Information on the problem's setting, including any development plans and short-term travel forecasts, should be assembled and reviewed to identify "opportunities" for action, "constraints" that may affect the feasibility or design of solutions, and "travel" that should be accommodated by any proposed actions.



A. Study Strategic Management Activities

The knowledge gained from a "conditions analysis" (identification of existing conditions) conducted as part of strategic management early in project planning will provide some information on the problems and their causes, but it may not be sufficiently detailed for project analysis and design. More information is needed to determine the underlying deficiencies in the transportation system that cause or contribute to the perceived problems; otherwise, some symptoms may be overlooked.

B. Analyze Existing and Anticipated Conditions

A field reconnaissance will help identify the operating conditions of existing facilities and the causes of identified problems. Efforts should be made to obtain and analyze accident reports; traffic or rider counts; the entity's long-range thoroughfare plan; and documented requests and complaints from the public, governmental staffs, public agencies, elected officials, and developers. Anticipated land use and travel changes may also lead to problems on other facilities in the immediate area. Resolving these problems in conjunction with immediate problems often will be cost-effective.

****
*** Short Quizzes for Self-Evaluation *** (Answers on page 33)
****

1. TSM stands for ______ ______ ______.
   It is aimed at using ______ transportation facilities ______.
   It places direct emphasis on ______, ______-______, and ______-______ planning and programming projects for transportation improvements.

2. Which one is *not* an example of TSM action profiles?
   A. Staggered Work Hours.
   B. Reversible Lanes.
   C. Network Simulation.

3. Provide the key term for each of the following definitions:
   A. Physical or operational change, or a specific change. ______
   B. Listing of applicable and effective considerations in the selected TSM actions. ______
   C. A group of proposed actions to solve a specific set of problems. ______
   D. A general approach that can be taken to solve specific problems. ______

4. Step-by-step TSM Process.
   Step 1: Assemble and Review ______.
   Step 2: Analyze ______ and Their Setting.
   Step 3: Identify Candidate ______ and ______.
   Step 4: ______ Actions for Applicability and Effectiveness.
   Step 5: Specify Initial ______ for Analysis.
   Step 6: ______ the Analysis.
   Step 7: Analyze Performance of ______ ______.
   Step 8: Analyze Secondary ______ of Solution Package.
   Step 9: ______ an Action Plan.

Step 1

5. Problem identification and assessment conducted as part of ______ early in project planning will provide some information on the problems and their causes.

6. Anticipated land use and travel changes may create traffic operational problems. True or False?

****

STEP 2. ANALYZE PROBLEMS AND THEIR SETTING

A. Collect Performance Data

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts
9. Recommend An Action Plan

As part of their system monitoring activities, agencies routinely collect performance data such as traffic volumes, travel times and delays; transit patronage, running times, and load factors; and parking accumulation, turnover, and duration. Plots of performance data are helpful in illustrating the performance level of existing facilities and provide a benchmark for assessing the effectiveness of proposed solutions. The plots also indicate where additional information may be required. If additional data collection appears warranted, a quick review of the subsequent planning steps should be made to ensure that information necessary for completing the remaining steps can be collected at the same time.

B. Assess and Identify Problems

To simplify field reconnaissance and performance analysis, worksheets for recording and appraising physical and operational conditions on the facilities are useful in identifying and assessing problems. Techniques described in the Impact Estimation and Analysis Aids (**Method Selection Aids** on pages 117–141 in *NCHRP Report 263*) can be used to estimate operational capacities and other performance measures that are difficult to measure directly. The aids also cover travel forecasting and other techniques that can be used to analyze future conditions resulting from anticipated growth or development in the study area.

Recording and assessment of the problems normally should include:

1. **Geometric and alignment characteristics** (e.g., pavement width, lane width, and horizontal and vertical curvature).
2. **Physical condition** (e.g., damage and wear on structures, roadbed, pavement, and curbs).
3. **Signing** (e.g., signal and sign design and placement, and striping design and condition).
4. **Safety** (e.g., accidents and accident rates, presence and condition of warning devices, guardrails or other protection).
5. **Service quality** (e.g., operating speeds, delays, volume/capacity ratios, schedule adherence and coverage).
6. **Productivity** (e.g., passenger-miles or passengers boarded per driver-hour, per vehicle-mile, or vehicle-hour).
7. **Cost recovery** (e.g., percentage of operating costs covered by farebox revenues).

In many cases, ratings or scores can be assigned to specific facilities or services and compared to standards or criteria to measure the severity of a problem. **Notes on Evaluation and Packaging Techniques** (E/P Note 1: Problem Assessment Techniques on pages 167–169 of *NCHRP Report 263*) in the Reference Handbook discuss some of the problem assessment procedures.

C. Develop Graphical Representations

After the problems have been assessed and identified, a useful way of addressing many of these issues is to graphically illustrate information related to the problems and their setting. A simple display of problems on corridor or community base maps often illustrates relationships among the measured or perceived problems, highlights underlying causes, and leads to coordinated solutions. Graphical representations are very effective in explaining the problems to nontechnical individuals, especially to city councils and civic groups.

D. Sketch a Plan

Estimation techniques used in project design and analysis also can be used at a sketch planning level to provide a better understanding of identified problems. Sketch plan analysis may connect problems that appeared unrelated at first glance, and indicate solutions that would be overlooked if individual problems were treated separately.

STEP 3. IDENTIFY CANDIDATE STRATEGIES AND ACTIONS

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts
9. Recommend An Action Plan

Once the problem is clearly defined, general approaches and strategies should be pursued in developing solutions (such as improve traffic flow or encourage transit use), as well as in implementing actions that might be considered as part of these strategies (such as signal improvements or increased bus frequency). The scales of action (e.g., implementation within an employment center versus along approach corridors) also must be considered so other agencies and their representatives can be brought into the planning process.

After performing an initial problem analysis, more extensive courses of action that might be relevant to initial problems and objectives should be considered. These courses of action may include transit actions to help solve traffic problems and operational actions to help solve capacity problems. This step should produce some basic, feasible approaches to solving the problems, and actions that might form the core of packages designed to implement these approaches. The **TSM Action Identification Tables** (pages 40–58 in *NCHRP Report 263*) are designed to assist in this step.

STEP 4. SCREEN ACTIONS FOR APPLICABILITY AND EFFECTIVENESS

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts
9. Recommend An Action Plan

Candidate strategies and actions must be screened to see if they are realistic in terms of the actual or anticipated land uses and densities (e.g., adequate population densities to support a transit route extension), the transportation system and facility characteristics (e.g., adequate rights-of-way to allow a two-way left-turn lane), and travel volumes and patterns (e.g., long commuting distances that make vanpooling attractive). Physical, operational, and political feasibility should be considered as well (e.g., existing medians and channelization may interfere with a proposed reversible lane). Information on their likely effectiveness should be obtained to help "weed out" ineffective actions and to assist in "packaging" designed solutions. Potential impacts that may require mitigation should be identified in this step because they may affect the feasibility or basic design of proposed packages.

At this stage of the process, analysts may look for information on actions implemented in similar situations or for general "rules of thumb" as the basis for making screening decisions. Simple sketch-planning analyses also may be appropriate. Analysts should develop **Action Screening Worksheets** which illustrate the screening process based on the project, site condition, and professional judgment. (An example of such a worksheet is shown on page 31 of *NCHRP Report 263*).

Analyzing a complex corridor or subarea problem involves considerable iteration and refinement in the remaining tactical planning steps to develop a workable and acceptable solution. Therefore, the worksheet should be carefully developed and maintained until the project is completed. The **TSM Action Profiles** (pages 59–112 in *NCHRP Report 263*) provide applicability conditions and other screening information.

STEP 5. SPECIFY INITIAL PACKAGES FOR ANALYSIS

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts
9. Recommend An Action Plan

The actions that survive the screening step usually are not sufficiently detailed to permit implementation; hence, a starting point is needed for analysis and design. In many situations, the nature of the problems almost mandates the solutions, so a single package will suffice. In more complex situations, two or three packages representing different strategic approaches may need to be designed. Unlike systems planning, however, these alternatives will be modified, refined, discarded, or combined as necessary during the design process. The design, analysis, and evaluation of project packages is an iterative process involving the remaining steps of the nine-step process.

****

*** Short Quizzes for Self-Evaluation *** (Answers on page 33)

****

Step 2

7. __________ of performance data are helpful in illustrating the performance level of existing facilities.

8. In order to simplify field reconnaissance and performance analysis, __________ are useful in identifying and assessing problems.

9. Graphical representations are not effective in explaining the problems to non-technical individuals. True or False?

Step 3

10. Once the problem is clearly defined, the analyst should look for general approaches and __________ (such as improve traffic flow), as well as specific types of __________ (such as signal improvements).

11. TSM __________ __________ Tables in NCHRP Report 263 are designed to assist in identifying candidate strategies and actions.

Step 4

12. Candidate strategies and actions must be __________ to see if they are realistic in terms of the project.

13. TSM __________ __________ in NCHRP Report 263 provide applicability conditions and other screening information.

Step 5

14. The actions that survive the screening step usually are not sufficiently detailed to permit implementation. True or False?

****

STEP 6. PLAN THE ANALYSIS

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts
9. Recommend An Action Plan

An analysis plan should be prepared that covers "factors and criteria" (e.g., safety, physical integrity, service quality, productivity, or cost) to be used in evaluating solutions, "potential performance and impact measures" (e.g., capacity/supply, volumes, and service quality) needed for their design and analysis, and "techniques" for estimating the measures. A carefully scoped plan will help to avoid unnecessary and wasted effort, and ensure that the measures and information are prepared in sufficient detail for analysis and evaluation.

STEP 7. Analyze Performance of Solution Packages

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts
9. Recommend An Action Plan

Refining preliminary packages to produce implementable actions entails making a series of detailed decisions concerning the packages' design and operation. All analyses should be directed at providing information for those decisions and should be as simple as possible.

The initial action packages defined in Step 5 first should be analyzed in terms of primary performance measures, i.e., those that determine the extent to which the actions solve identified problem(s) or meet design objective(s). The choice of **primary measures** (i.e., **direct** transportation measures and **derived** measures) will reflect the circumstances and actions involved. The primary measures usually include one or more of the following **categories:**

A. Service quality (e.g., travel time or speed).
B. Capacity (e.g., vehicle and person carrying rates).
C. Volumes/usage (e.g., traffic volumes, transit ridership, or vehicle occupancy).
D. Safety (e.g., accidents or traffic conflicts).
E. Cost (e.g., capital, operating, and maintenance).

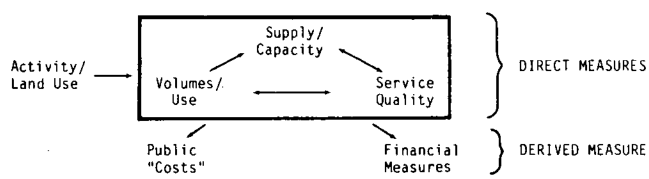


Figure IV-1. Basic relationships among performance measures.

Other measures, such as retail sales, aesthetics, air quality, and noise reduction also can be primary measures in situations where they are key factors in making design decisions.

Intermeasures are developed by combining direct and/or derived measures. Intermeasures may be used in project evaluation, or to compare the relative merits of different actions being considered for an investment program. Intermeasures include **productivity** measures (e.g., passenger-miles per vehicle-hour), **efficiency** measures (e.g., bus-miles per driver-hour), and **cost-effectiveness** measures (e.g., energy or travel time savings per dollar invested). In general, they are interpretive measures that help place a scale on performance levels and impacts.

The analysis should be viewed as a search for a good solution that meets financial, physical, and other constraints, not as an "alternatives analysis" where package specifications remain fixed. Consequently, actions should be modified, added, or discarded if analysis indicates that the changes would improve the performance of a package while retaining its feasibility. If the performance analysis indicates that the initial packages do not adequately solve the problems, the incremental contribution (or performance) of individual actions can be estimated and used as a basis for expanding or reducing their importance in the package.

Cost-effectiveness or benefit/cost analysis can be used in comparing actions and packages. These techniques are discussed in the **Notes on Evaluation and Packaging Techniques** (pages 166–177 of *NCHRP Report 263*), as are other approaches that agencies have used in developing and assessing packages of TSM actions. The analysis may suggest major or minor design modifications, as well as the need for additional or supportive actions. If no packages appear able to solve the problems, the problems themselves may have to be reassessed, or new evaluations or design criteria established.

STEP 8. Analyze Secondary Impacts of Solution Packages

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package

8. Analyze Secondary Impacts

9. Recommend An Action Plan

Only at this stage, after action packages have survived the tests of feasibility and effectiveness, should "secondary" issues and impacts be analyzed. Depending on the specifics of the problems and actions involved, the following issues might be examined:

A. Public opinion or community acceptance.
B. Institutional or legal issues.
C. Social, environmental, or economic issues.

As with the primary evaluation factors, the packages should be modified as required to bring the impacts to acceptable levels. If major modifications are made, their performance should be checked to ensure that the desired levels are still achieved and that the problems are still resolved.

Any interagency agreements that are required for smooth implementation and operation should be prepared at this time to ensure that proposed packages remain feasible. For example, discussions with the police department to draft an enforcement plan will indicate whether adequate space has been provided for patrol cars and apprehended vehicles. The **TSM Action Profiles** (pages 57–112 of *NCHRP Report 263*) contain similar design and operational considerations for several actions, as well as references to reports and articles that describe operational experiences. *NCHRP Report 205,* "Implementing Packages of Congestion-Reducing Techniques, Strategies for Dealing with Institutional Problems of Cooperative Programs," discusses the institutional issues involved in implementing congestion-reduction measures.

STEP 9. Recommend an Action Plan

1. Assemble Information
2. Analyze Problems
3. Identify Strategies
4. Screen Actions
5. Specify Initial Packages
6. Plan the Analysis
7. Analyze Solution Package
8. Analyze Secondary Impacts

9. Recommend An Action Plan

The task of assigning priorities to short-range transportation projects is not easy. In the final analysis, this task is in the domain of elected officials and their appointed representatives. Professional transportation planners and engineers, however, have the responsibility of recommending projects and of presenting sufficient information about available alternatives to ensure that the final choices can be made on a rational and justifiable basis.

Following analysis and design, a TSM action or package for the study area should be recommended for implementation or for programming along with actions directed at other problems. The key to TSM is implementation, so the action plan should consist of an implementable "design" (e.g., detailed engineering or operational plans), not a proposal for further study. The plan also may include schedules for a staged implementation, any required review and design activities (e.g., preparation of an Environmental Impact Statement), and recommendations for possible supportive actions by other agencies. In many cases, a staging sequence that meets anticipated project budgets will be obvious to an agency staff. In other cases, cost-effectiveness or benefit/cost analysis may be useful. These techniques are described in the **Notes on Evaluation and Packaging Techniques** (pages 166–177 of *NCHRP Report 263*), along with other techniques that have been used to package and stage actions.

A major part of this step often is the presentation of recommendations to policy setting and programming officials or agencies, providing them with sufficient information to adopt the recommendation and to support the investment needed to implement and operate the package. Presentations to merchants and community groups also may be needed to obtain political support.

SUMMARY

In summary, the nine-step TSM process provides a practical and flexible framework for developing TSM solutions. The steps may be accomplished quickly when tackling a simple problem, while a complex corridor or subarea problem analysis may involve considerable iteration and refinement in Steps 6, 7, and 8 to develop a workable and acceptable solution. The "process" is a means to this end, and any paper products are merely incidental or supporting documents.

****
*** Short Quizzes for Self-Evaluation *** (Answers on page 33)
****

Step 6

15. An analysis plan should not be rigid and should be modified as new insights are gained in the course of the analysis. True or False?

Step 7

16. ________ __________ of existing and proposed operations are key to the analysis, design, and evaluation of TSM actions.

17. _________ include productivity measures, efficiency measures, and cost-effective measures.

18. Distinguish the following categories by direct measures *dir,* derived measures *der,* and intermeasures *int:* Service quality ______, Capacity ______, Volumes/usage ______, Safety ______, Public Cost ______, Air Quality ______, Passenger-miles per vehicle-hour ______, and Bus-miles per driver-hour ______.

19. ______-______ or ______/______ analysis can be used in comparing actions and packages. These techniques are discussed in the Notes on Evaluation and Packaging Techniques in NCHRP Report 263.

20. If no packages appear able to solve the problems, the problems themselves may have to be reassessed or new evaluation or design criteria established. True or False?

Step 8

21. In order to analyze secondary impacts of solution packages, legal or institutional issues might be examined. True or False?

Step 9

22. Professional transportation ________ and ________ have the responsibility of recommending projects and of presenting information.

23. TSM action plans should consist of an ________ design, not a proposal for further study.

24. A ________ sequence that meets anticipated project budgets may be obvious to an agency staff.

25. An analyst may proceed quickly through the steps in tackling a simple problem, while a complex corridor or subarea problem analysis may involve considerable ________.

****

SECTION V

COMPLETE EXAMPLE OF STEP-BY-STEP PROCESS

This section provides a comprehensive example to improve the reader's understanding of the TSM "evaluation" process. An urban arterial street corridor case study is presented which illustrates the step-by-step TSM process. This example demonstrates the practical application of the evaluation procedure.

The nine-step TSM Decision-Making Process is applied to a recent TSM study along a major transportation corridor (29th Street) in the twin cities of Bryan and College Station, Texas. Bryan/College Station is located approximately 90 miles northwest of Houston, Texas, and has a combined population of about 125,000. The 29th Street Corridor extends from Texas Avenue near the Bryan CBD south to University Drive in College Station. Because the 29th Street Corridor Study was initiated by the City of Bryan, the essential limits of the study were Texas Avenue and the Bryan city limits (see Figs. V-1 and V-2).

STEP 1. ASSEMBLE AND REVIEW INFORMATION

In 1982, the 29th Street Corridor Study was initiated because of the emergence of several traffic operational problems on the roadway. First, accidents at intersections within the corridor had increased above an acceptable level. Second, considerable delay and queuing had been experienced along certain sections of the street, particularly in the Barak and Briarcrest intersections and surrounding areas. Finally, new development was expected to increase traffic volumes considerably and add to existing problems in the next 5 years if no corrective measures were taken.

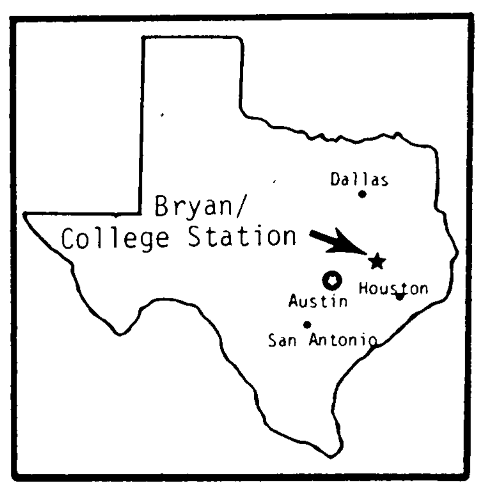


Figure V-1. Vicinity map.

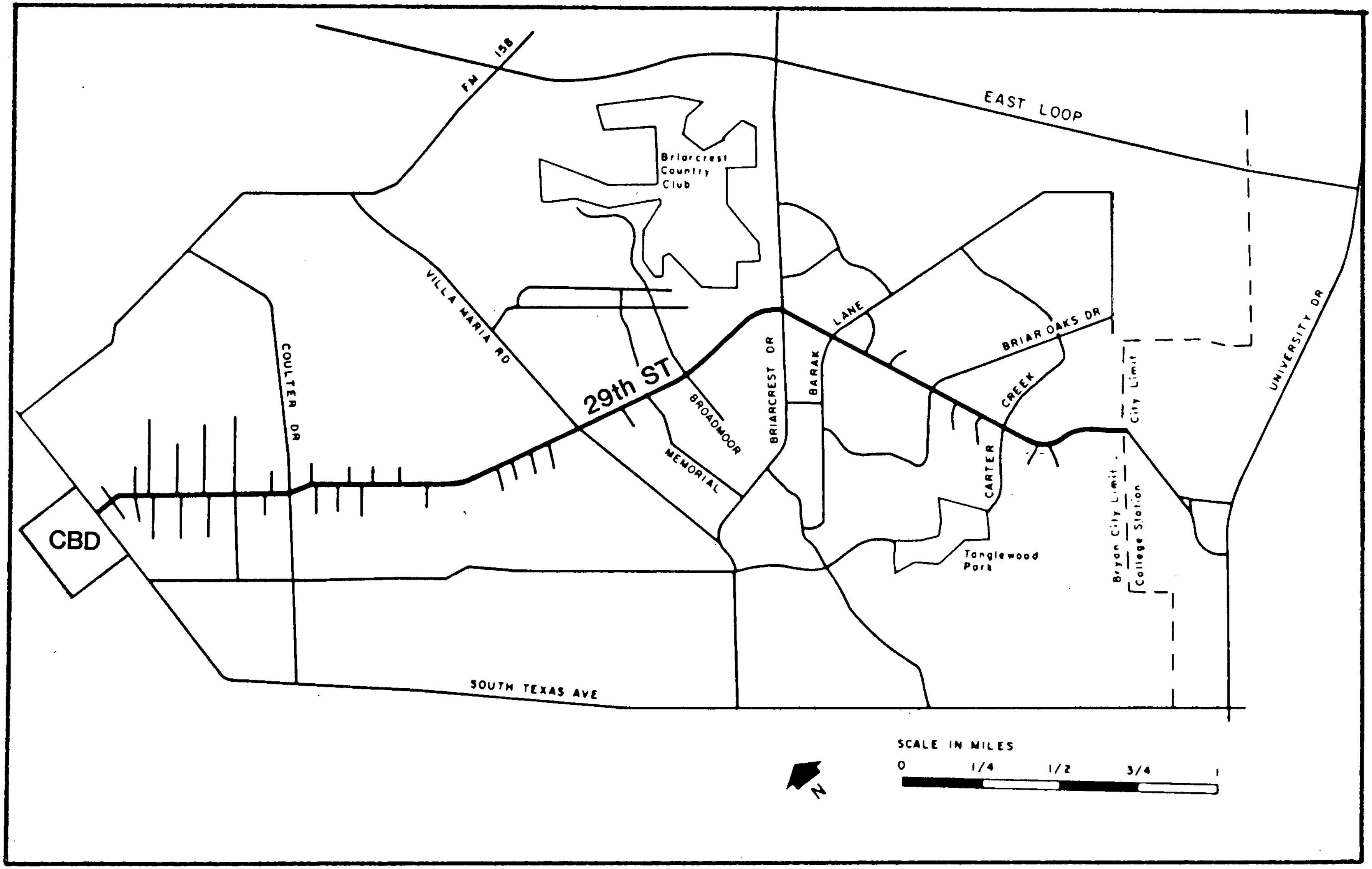


Figure V-2. Site map.

A. Study Strategic Management Activities

Limited financial resources and short implementation times restricted the selection of many potential TSM actions. Only minimum right-of-way acquisition would be permitted because of excessive costs and extensive existing development. Large capital expenditures to expand or rework the existing roadway structure could not be considered. A quick improvement was desired which would return considerable user benefit at a relatively low cost.

B. Analyze Existing and Anticipated Conditions

Initially, 29th Street served as a collector street. As the community grew south and east, 29th Street was lengthened and widened to accommodate two lanes of traffic and parking. Increased traffic volumes necessitated removal of parking and maximum use of available paved surface for traffic flow. In 1982, the City of Bryan contracted with a local consulting engineer firm to perform an analysis of the corridor and recommend improvements.

With the exception of a 0.2-mile section of a 63-ft-wide, five-lane cross section centered at one major intersection, the entire length of the 29th Street Corridor (about 3.5 miles) consists of a four-lane cross section 38 to 40 ft wide. Existing right-of-way ranged from 50 to 80 ft, but primarily consisted of 60 ft.

Development adjacent to the northern half of the corridor, the section between Villa Maria Road and Texas Avenue, consisted primarily of residences, apartment complexes, a few commercial developments, and vacant lots. Develoment adjacent to the southern half of the corridor, the section between Villa Maria Road and the Bryan city limits, consisted of commercial areas, shopping centers, a medical complex, a large high school, office buildings, and apartment complexes.

The southern half of the corridor, particularly the area in the vicinity of Briarcrest Drive, is experiencing dynamic growth as the major business district in the City of Bryan is shifting toward the Briarcrest Drive and 29th Street corridors. Development of one major bank/office building was completed near the intersection of the two roadways in 1985, and another is currently under construction. Both complexes have stimulated additional development of commercial establishments. Development of another bank/office complex and a major hotel at the southern end of 29th Street in College Station will encourage additional development along the 29th Street Corridor (see Fig. V-3).

After determining both present and future basic conditions along the 29th Street Corridor, selected information was collected. This information included reports from previous traffic studies on 29th Street, accident reports pertinent to the corridor, Bryan's long-range major thoroughfare plan, and comments from the city staff, mayor, and council.

STEP 2. ANALYZE PROBLEMS AND THEIR SETTING

A. Collect Performance Data

Performance data were collected in the form of traffic volumes. Average daily traffic volume counts and approach volume and turning movement counts were made at all major intersections along the corridor (see Table V-1). Other performance data collected included signal timings, travel time determinations, and a count of through traffic using the corridor. Graphical representations were made of the traffic volume counts, accident histories at major intersections (see Fig. V-4), and signal phasings and timings (see Fig. V-5). Typical hourly traffic distribution curves for 29th Street are shown for two different sections (see Fig. V-6).

B. Assess and Identify Problems

In order to assess the 29th Street problems, certain deficiency criteria were applied against the existing operational problems. These criteria comparisons fall into the following areas: traffic volume supply/street capacity, service quality of street operations, accident incidence, and other general considerations. The results of these comparisons are summarized as follows:

1. *Traffic Volume Supply/Roadway Capacity:*
    - Narrow lane width of 10 ft each and no left-turn lane.
    - Short left-turn storage bay at major intersections.
    - Curb return radii less than 20 ft.
    - Inadequate signs and pavement markings.
    - Inadequate traffic control.
    - Radii of curvature of 6 of 8 horizontal curves too small.
    - Sight distance deficient at 5 horizontal curves and 4 intersections.
    - Close building setbacks in several locations.
    - Short spacing between signalized intersections.
    - Large number of "curb cut" access points.
    - Narrow right-of-way.
2. *Service Quality of Street Operations:*
    - Expected level-of-service lower than "C".
    - Peak travel speed under 25 mph.
    - Four to five complete stops required along the corridor.
    - Delay and queuing at Barak and/or Briarcrest intersections.
3. *Safety and Accidents:*
    - High annual accident rate.
    - High percentage of nighttime accidents.
    - Pedestrian accidents at the high school.
    - Poor lighting system.
    - Close portable business advertising.
4. *General Considerations:*
    - Lack of sidewalks for the pedestrian.
    - Congestion from vehicles delivering and picking up students.
    - Flat pavement cross section resulting in poor drainage.

C. Develop Graphical Representations

Graphical representations of problem areas were prepared for the 29th Street Corridor Study, primarily for discussion purposes with City Staff and City Council (see Fig. V-7).

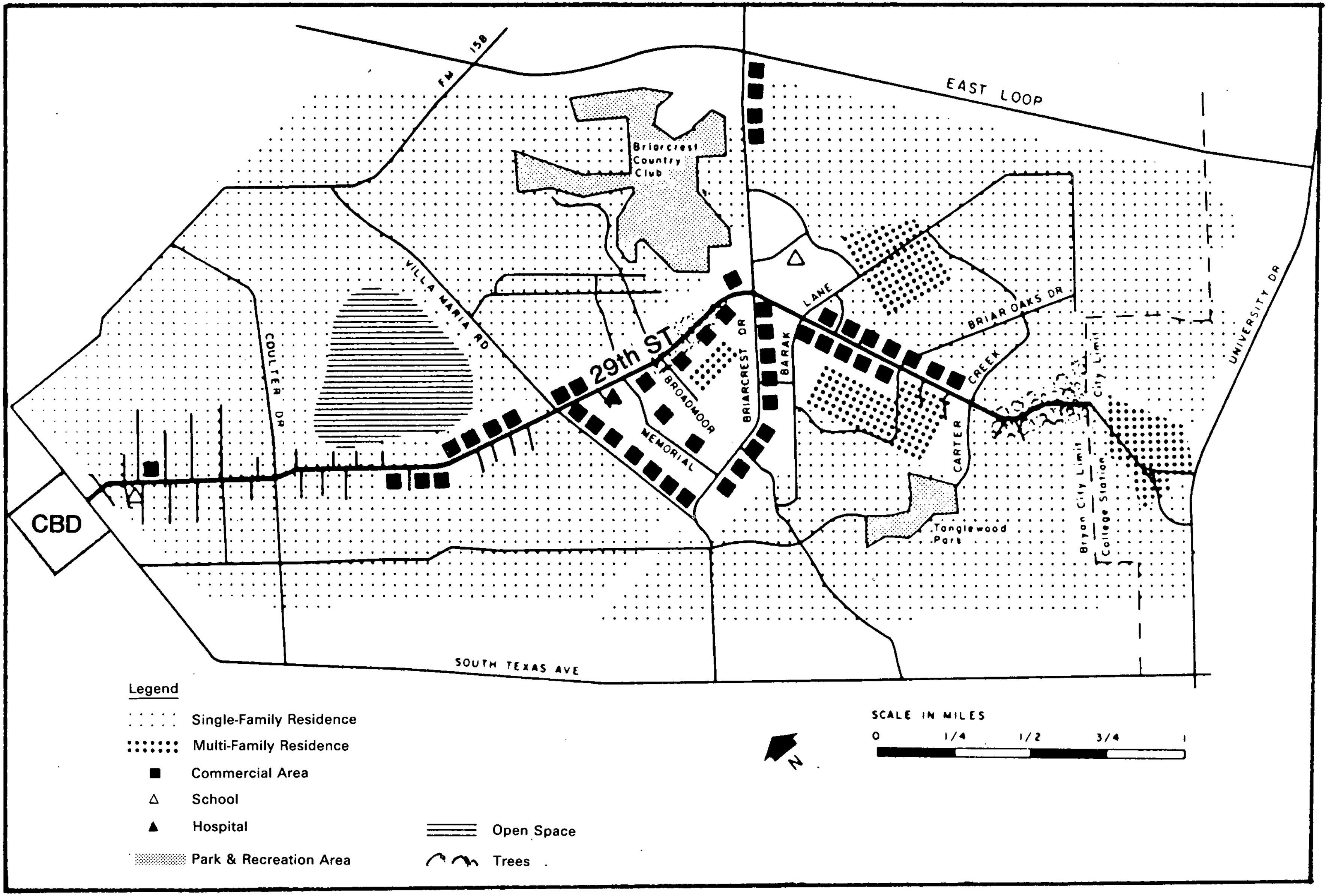


Figure V-3. Existing land use.

Table V-1. Sample traffic count summary sheet.

Location Briarcrest @ 29th St. Date 3-30+31-83
Weather CLOUDY Road Surface Condition Dry

TIME STARTS ___M.	from North on Briarcrest St.			from East on 29th St.			from South on Briarcrest St.			from West on 29th St.			HOUR TOTAL
	R	S	L	R	S	L	R	S	L	R	S	L	
7:00-7:15	16	42	12	17	27	21	10	39	6	4	27	18	239
7:15-7:30	24	76	20	5	46	23	15	36	4	7	37	23	316
7:30-7:45	41	127	43	19	80	38	13	66	8	4	68	50	557
7:45-8:00	38	145	51	21	100	55	32	86	12	3	77	72	692
8:00-8:15	40	149	35	27	97	72	45	103	12	4	100	86	770
8:15-8:30	49	140	27	14	76	33	30	50	11	6	59	31	526
8:30-8:45	32	68	9	9	39	20	15	40	5	10	40	8	295
8:45-9:00	24	73	25	10	49	35	18	42	8	8	48	19	359
11:30-11:45	28	102	29	15	72	50	34	94	14	2	39	27	506
11:45-12:00	37	88	36	23	97	52	44	100	18	13	78	48	634
12:00-12:15	30	73	23	35	67	42	45	132	18	8	87	91	651
12:15-12:30	36	91	32	23	63	24	45	103	20	6	65	35	543
12:30-12:45	50	115	20	21	72	59	32	99	16	16	74	34	608
12:45-1:00	52	115	38	22	88	49	35	86	17	8	44	34	588
1:00-1:15	47	105	43	28	83	54	37	106	17	4	84	59	667
1:15-1:30	59	86	33	21	82	44	36	89	14	10	57	34	565
3:00-3:15	31	71	22	25	68	37	33	92	14	7	84	57	541
3:15-3:30	34	87	25	33	69	47	43	88	15	8	90	35	574
3:30-3:45	72	96	45	23	93	51	58	84	17	12	96	58	705
3:45-4:00	78	102	36	27	94	57	37	102	18	14	80	42	687
4:00-4:15	8	90	32	28	84	48	41	105	17	15	45	44	557
4:15-4:30	16	93	57	36	102	61	45	117	24	21	103	45	720
4:30-4:45	21	113	23	30	85	46	51	108	25	15	92	42	651
4:45-5:00	11	113	49	46	123	41	33	136	30	16	102	85	785
5:00-5:15	7	41	10	19	50	17	21	64	12	4	53	33	331
5:15-5:30	20	92	22	43	85	33	47	166	36	18	83	42	687
5:30-5:45	17	93	41	40	69	32	46	166	20	2	87	55	668
5:45-6:00	27	81	30	43	79	39	39	143	19	11	46	42	599
Total													
TOTAL													

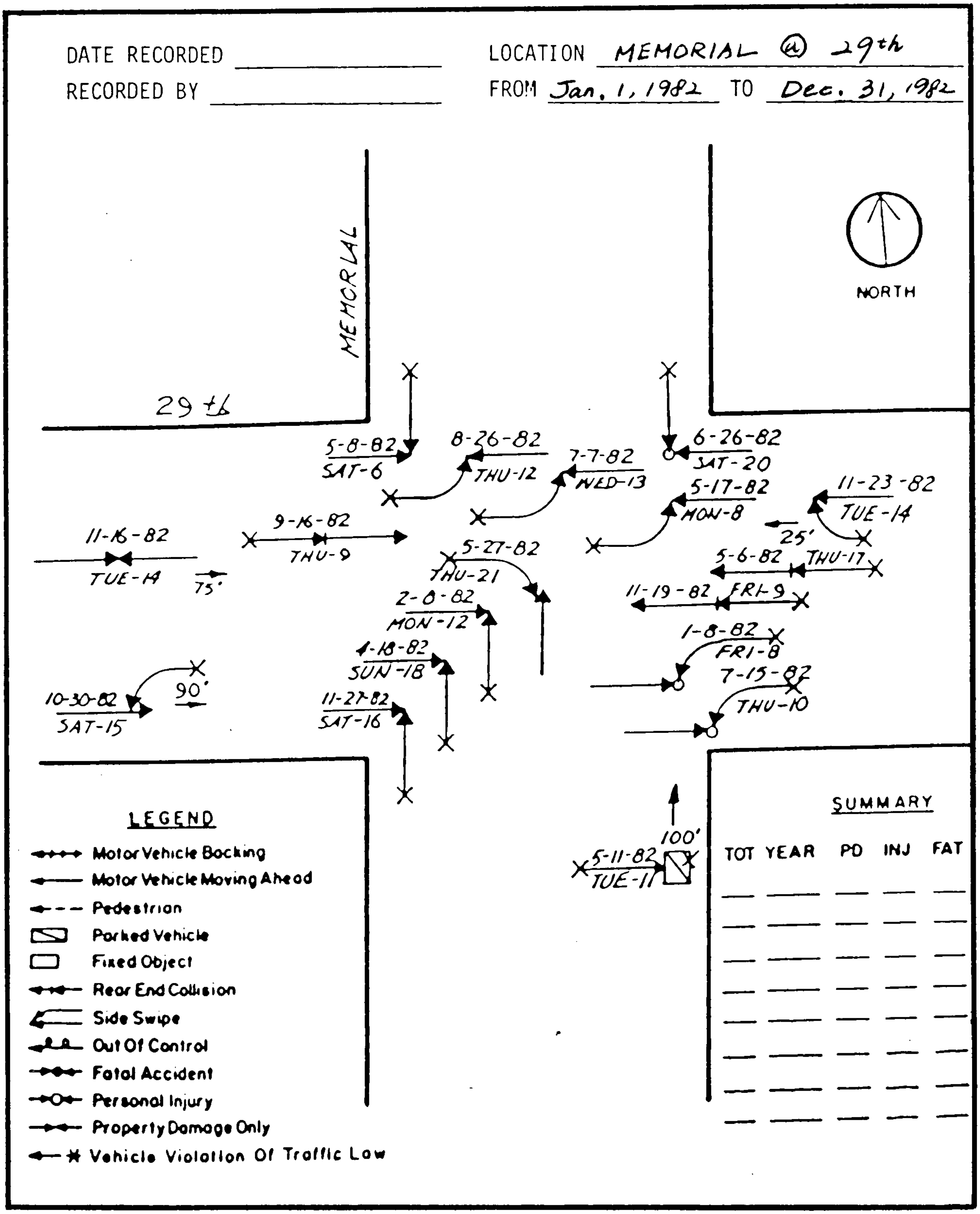


Figure V-4. Sample intersection collision diagram.

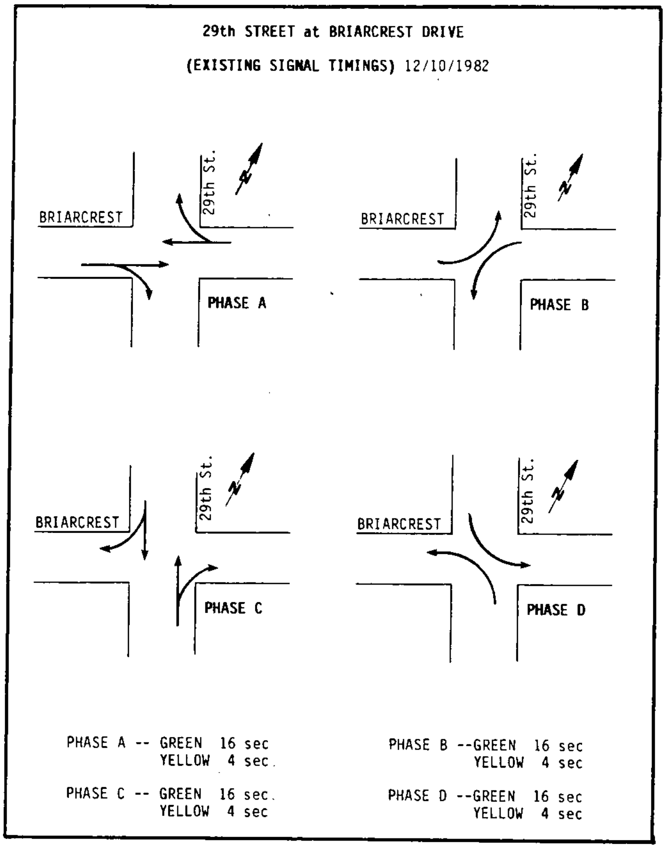


Figure V-5. Sample signal phasings and timings.

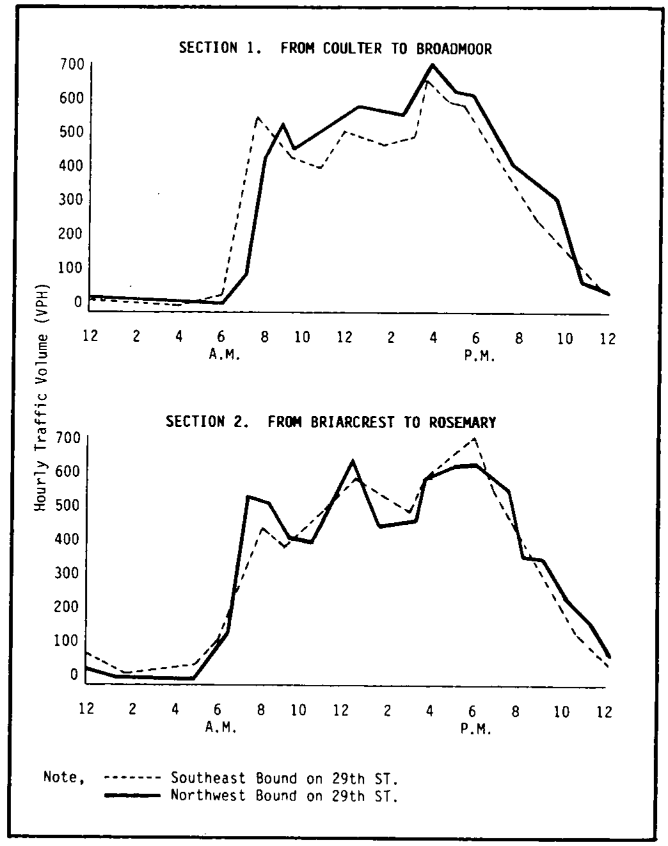


Figure V-6. Hourly traffic distribution.

D. Sketch a Plan

An objective review of initial conceptual TSM improvements in relation to anticipated city-wide transportation improvements indicated no major obstacles.

STEP 3. IDENTIFY CANDIDATE STRATEGIES AND ACTIONS

Limited financial resources and short implementation times restricted the selection of many potential TSM actions. Potential actions had to accomplish three major objectives:

1. Increase capacity to accommodate anticipated traffic volumes.
2. Improve the traffic flow and minimize traffic delays.
3. Provide for safe movement of pedestrians.

Action Identification Tables 1 and 2 in *NCHRP Report 263* include listings of possible problems associated with intersections/street segments and corridors. Page 40 of *NCHRP Report 263* lists three primary problems under the heading "Isolated Intersections or Street Segments" and four primary problems under the heading "Corridors." The following problems were pertinent to the 29th Street Corridor:

1. *Isolated Intersections or Street Segments:*
   - Vehicle Flow Conflicts and Accidents
   - Traffic Congestion
   - Pedestrian Safety
2. *Corridors:*
   - Traffic congestion on Arterial Streets
   - Traffic Congestion on Cross-Corridor Roads

On pages 42 to 45 of *NCHRP Report 263,* several different actions that can be applied along the corridor are listed for consideration under the three headings pertinent to the 29th Street Corridor. Many of the actions cannot be implemented along 29th Street, particularly those associated with transit, because the City of Bryan does not have a transit system. Many other possible actions like under/overpasses, one-way pairs, and parking modifications also were not applicable to 29th Street. Actions involving roadway widening and signal timing and phasing changes were pertinent to the 29th Street Corridor. The listing of these actions was the result of Step 3.

STEP 4. SCREEN ACTIONS FOR APPLICABILITY AND EFFECTIVENESS

The actions listed at the end of Step 3 were screened to determine if they could be implemented in terms of the trans-

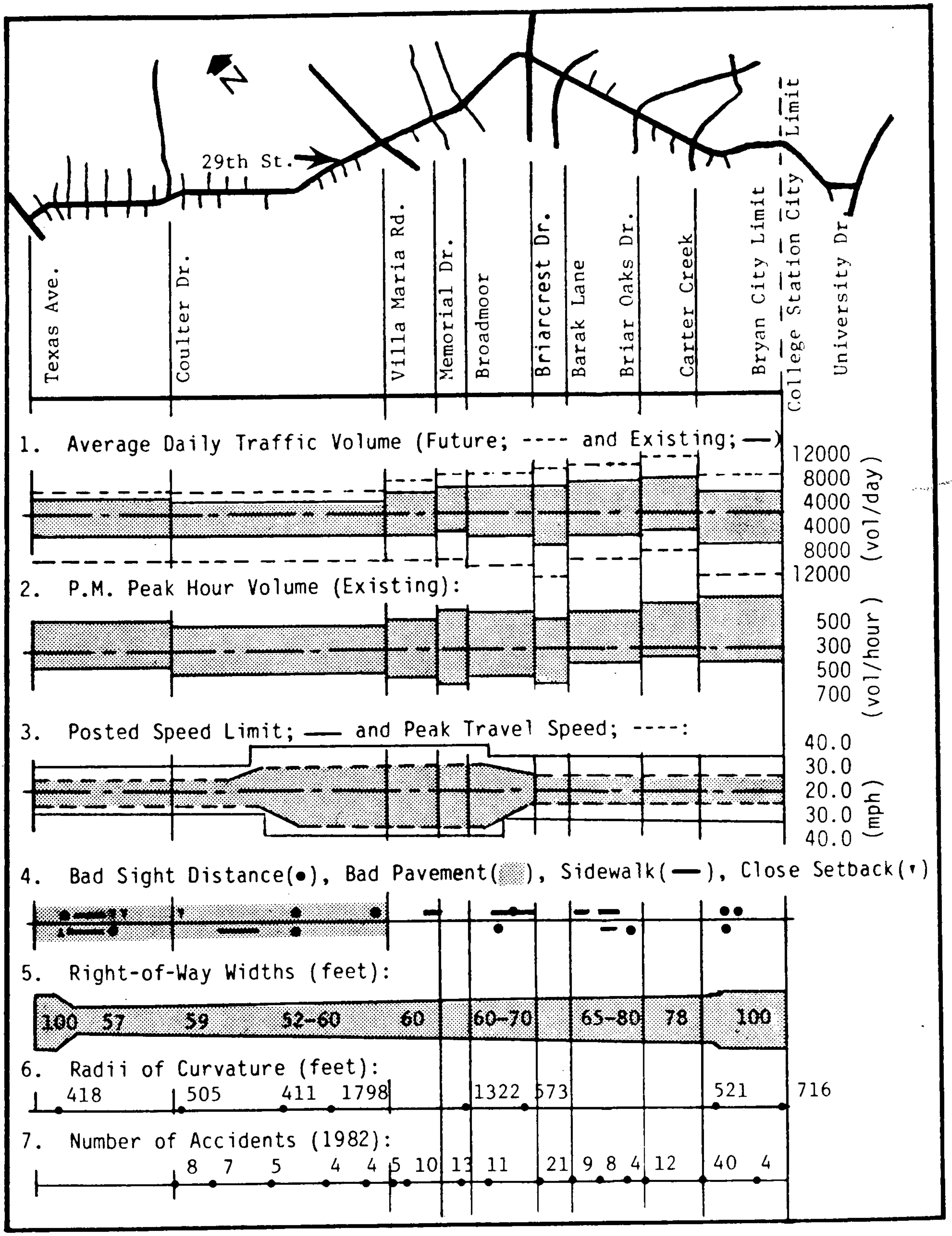


Figure V-7. Problem summary.

portation system and facility characteristics, as well as travel volumes and patterns. Some were eliminated, like reversible lanes. Since existing peak-hour volumes on 29th Street are virtually split evenly in the two directions, reversible lanes were not considered as an effective solution.

Limitations on availability of right-of-way acquisition significantly restricted the possibility of widening the roadway. However, increased roadway capacity was a definite requirement. The actions finally selected had to be conducive to increasing roadway capacity. Action Screening Worksheets were developed to illustrate the screening process (see Fig. V-8). The TSM Action Profiles 16–22 on pages 80–88 of *NCHRP Report 263* were used for reference.

STEP 5. SPECIFY INITIAL PACKAGES FOR ANALYSIS

Based on problem identification and screening work carried out with the Action Screening Worksheets, two action packages were selected for analysis. One package of actions involved the widening of the roadway by 15 ft, the maximum width possible that could be implemented without requiring substantial acquisition of existing commercial establishments. The second package included signalization and lighting improvements for both safety and improved traffic flow through the corridor.

STEP 6. PLAN THE ANALYSIS

Design and evaluation criteria pertinent to the 29th Street Corridor were chosen based on assessments of both existing problems and deficiencies, and future problems anticipated from an approximately 40 percent increase in traffic volumes from 1982 to 1990. Other serious problems included traffic delay and congestion, and excessive accident rates at the major intersections. The design and evaluation criteria used are listed below:

1. *Supply/Capacity:*
   - Signs, signals, and markings in conformance with MUTCD standards.
   - Left-turn storage bays at least 100 ft in length.
   - Separate left-turn lanes at signalized intersections.
   - Turning radii at least 20 ft at intersections.
   - Horizontal curvature radii at least 500 ft.
2. *Service quality:*
   - Design LOS "C" or higher at intersections.
   - No queuing or delay at intersections.
3. *Safety:*
   - Lighting in conformance with EIP standards.
   - Surface condition maintained to minimize wet-weather accidents.
   - Sidewalks provided on both sides of street.
   - Corner clearance at least 400 ft.

Potential evaluation factors for the selected types of actions can be found in Action Profiles 19–22 on pages 84–88 of *NCHRP Report 263*. The Impact Estimation and Analysis Aids on pages 113–164 of *NCHRP Report 263* provide detailed guidelines on selecting performance measures and estimation techniques.

STEP 7. ANALYZE PERFORMANCE OF SOLUTION PACKAGES

The selected design of the roadway improvement in general was a continuous section of 55-ft-wide paved surface along the southern half of the 29th Street Corridor from Carter Creek to Villa Maria. Widening the northern half of the corridor was cost-prohibitive. The proposed cross section in the southern half consisted of five 11-ft-wide lanes, two lanes for each direction of travel, and a continuous two-way left-turn lane. The widening would take place primarily on one side of the road, but would make a transition from one side to the other to increase the radius of the most severe horizontal curve.

Capacity would be increased by about 50 percent with this improvement. Safety would be increased by installing a continuous left-turn lane for storage of turns at intersections and along the entire corridor at midblock locations. Additionally, curb return radii would be lengthened and some access points would be removed.

Proposed signal improvements included four new signal installations and modernizations of the existing four signal installations. The signal system would include signal progression to improve traffic flow through the corridor. In addition, safety lighting was to be installed at all signalized intersections.

Analyzing a segment from Carter Creek to Briarcrest, in which progressive movement was achieved among the signalized intersections, peak travel speeds and bandwidths based on 1990 traffic projections ranged from 38.1 mph and 14.4 sec to 39.8 mph and 16.9 sec for the northbound and southbound directions, respectively. A time-space diagram is shown in Figure V-9. Based on this result, peak travel time in the segment could be reduced from 2.85 min in 1982 to 1.25 min in 1990. It was safe to conclude that a continuous speed of 35 mph in 1990 traffic could be obtained from progressive movement adaptation. Finally, as another result, all intersections were forecast to serve at a LOS "C" or higher with no delay for through traffic.

Table V-2 illustrates the benefits anticipated from the applicatons of the solution packages. Transient 1990 travel time through the route is anticipated to decrease from 9.5 to 5.6 min, or 41 percent, from the use of TSM. Average corridor speed is expected to increase from 21 to 35 mph, or 67 percent, in 1990

Table V-2. Summary of performance.

PERFORMANCE MEASURE		UNIT	1982(EXISTING)	1990(NO TSM)	1990 (TSM)
Average Daily Traffic		veh/day	12,900	18,000	18,000
Level-of Service		- - -	"B" to "D"	"D" to "E"	"C"
Travel Time		minutes	8.10	9.50	5.60
Average Speed		mph	27.50	21.00	35.00
Fuel Consumption		gal/yr*	499,700	721,400	578,600
Fuel Emission	CO	lb/yr*	941,000	1,722,000	1,050,000
	HC	lb/yr*	104,500	169,200	117,000
	NOx	lb/yr*	83,600	93,400	117,000
Accidents		acc/yr	172	189(+10%)	120(-20%)

* Year of 260 working days, based on 82 percent of ADT for the period 7:00 a.m. to 7:00 p.m.

ACTION SCREENING WORKSHEET NO. 1:
Problem 1, Traffic Delay and Congestion

Candidate Strategies/Actions	Notes/Comments	Pursue
• Reduce delays and congestion by adding capacity		
- new turn lanes	- at intersections where they don't presently exist.	Yes
- new islands	- useful to modify existing intersections	Yes
- new traffic signals	- major intersections already or soon to be signalized	Yes
- under/overpasses	- not necessary	No
- new lanes	- insufficient r.o.w., too costly; too much time involved	Maybe
• Reduce delays and congestion through more effective use of existing capacity		
- signal coordination	- necessary to tie groups of signalized intersections together	Yes
- signal phasing and timing changes	- necessary to achieve progression and greater efficiencies	Yes
- modified intersection geometry	- will be needed to provide efficient flow at intersections	Yes
- medians	- too consuming of existing roadway width	No
- turn prohibitions or rerouting	- added traffic on side streets may rule this out. Candidate streets for rerouting are marginal at best	No
- access control change	- virtually impossible to change what is present without voluntary cooperation of businesses, schools and hospital. Can't be done with residences	Maybe
• Reduce delays and congestion by encouraging trips to be made at less congested times		
- flexible working hours	- possible with some employers	Maybe
- change school hours, staggered hours	- possible at high schools in conjunction with staggered hours of staff	Maybe
- staggered lunch hours at high school	- possible in total scheme of staggered class hours	Maybe
- public education	- informing by radio of congestion development. TV spots on peak traffic times	No
• Reduce delays and congestion by encouraging trips to use parallel arterials, etc.		
- geometric improvements for access roads	- possible at high school and Briarcrest to send more traffic eastbound on Briarcrest	Maybe
- signalization improvements on access roads	- probably would have no impact on 29th Street traffic impacts	No
• Reduce delays by increasing speed on roadway segments		
- repair buckled concrete joints	- moderately costly to achieve marginal gains in speed	Maybe
- improve lane striping and buttons	- moderately costly to maintain both striping and buttons on an annual basis	Maybe
• Do nothing	- unacceptable alternative	No

Figure V-8. Sample (portion) action screening worksheet.

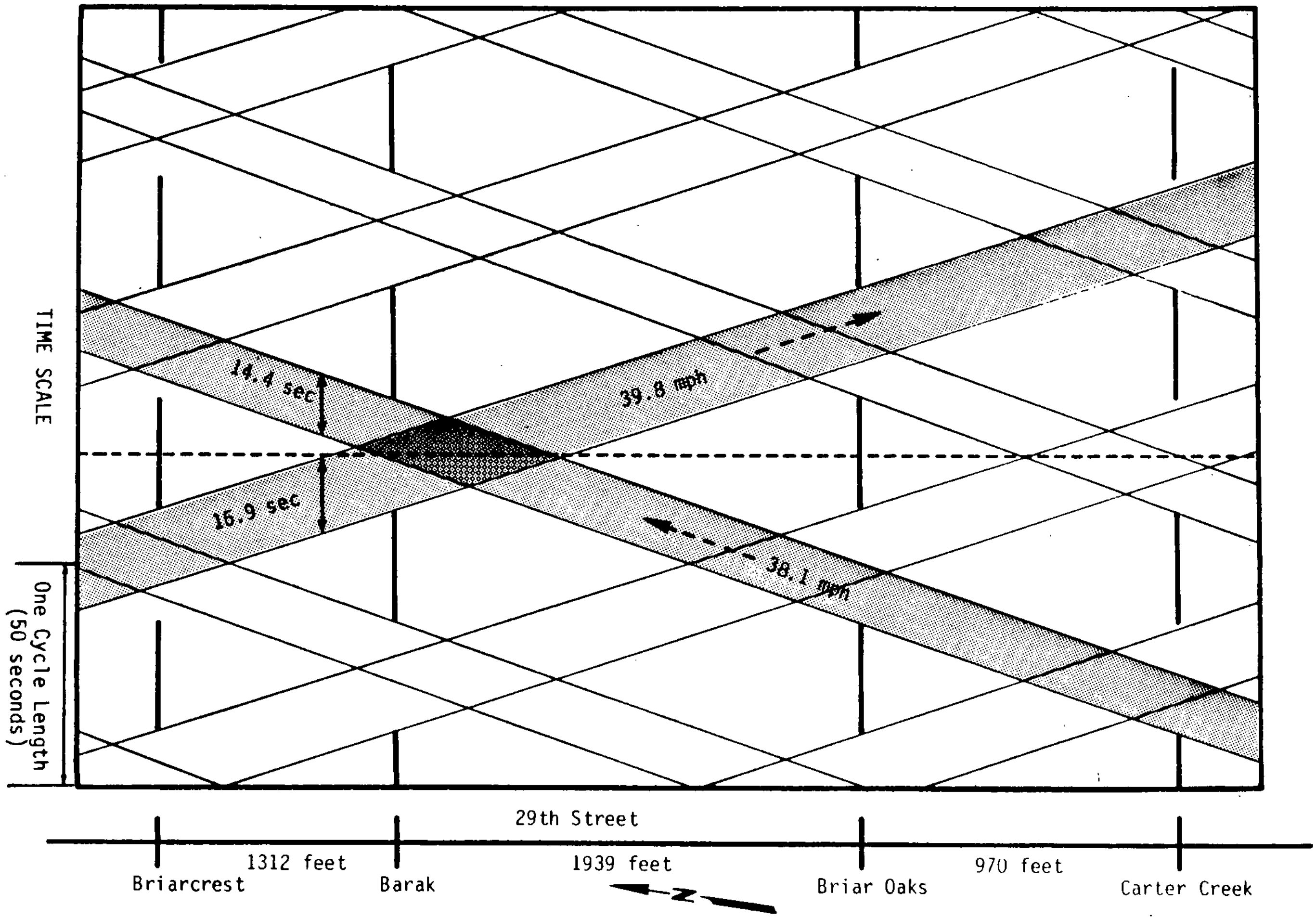


Figure V-9. Time space diagram.

traffic from TSM improvements. Compared with the 1982 accident rate, 1990 accidents are expected to increase 10 percent without TSM, but decrease 30 percent with this guidance.

Although a 40 percent increase in vehicular traffic for 1990 over 1982 is expected, total annual fuel consumption for 260 working days of the year is expected to rise only 16 percent as a result of using the solution packages. Considering total aggregate annual emissions of CO, HC, and NOx, these are expected to rise only slightly to moderately at 12, 12, and 40 percent, respectively, from 1982 to 1990.

Note 3 on Evaluation and Packaging Techniques, called Cost-Effectiveness and Benefit/Cost Analysis on pages 172–175 of *NCHRP Report 263,* was used to evaluate the project. Costs for the improvements were estimated to be approximately $2,000,000, with an implementation period of about 5 years. The anticipated benefits from the improvements when compared to their costs were considered to be a "bargain."

STEP 8. ANALYZE SECONDARY IMPACTS OF SOLUTION PACKAGES

The only negative effect of the proposed improvements was the loss of about 30 total parking spaces at four commercial sites. Existing parking lots were redesigned by the City's engineering consultants to minimize the loss of spaces. When each of the four owners of the commercial sites was visited and shown the proposed improvements, including the proposed parking lot redesigns, no objections were raised. All four recognized that the overall benefit to the City and to their businesses would be significant and worth the minor loss of spaces. The improvements were recognized as a major improvement to traffic safety. As a result, the City of Bryan requested funding support from the State of Texas.

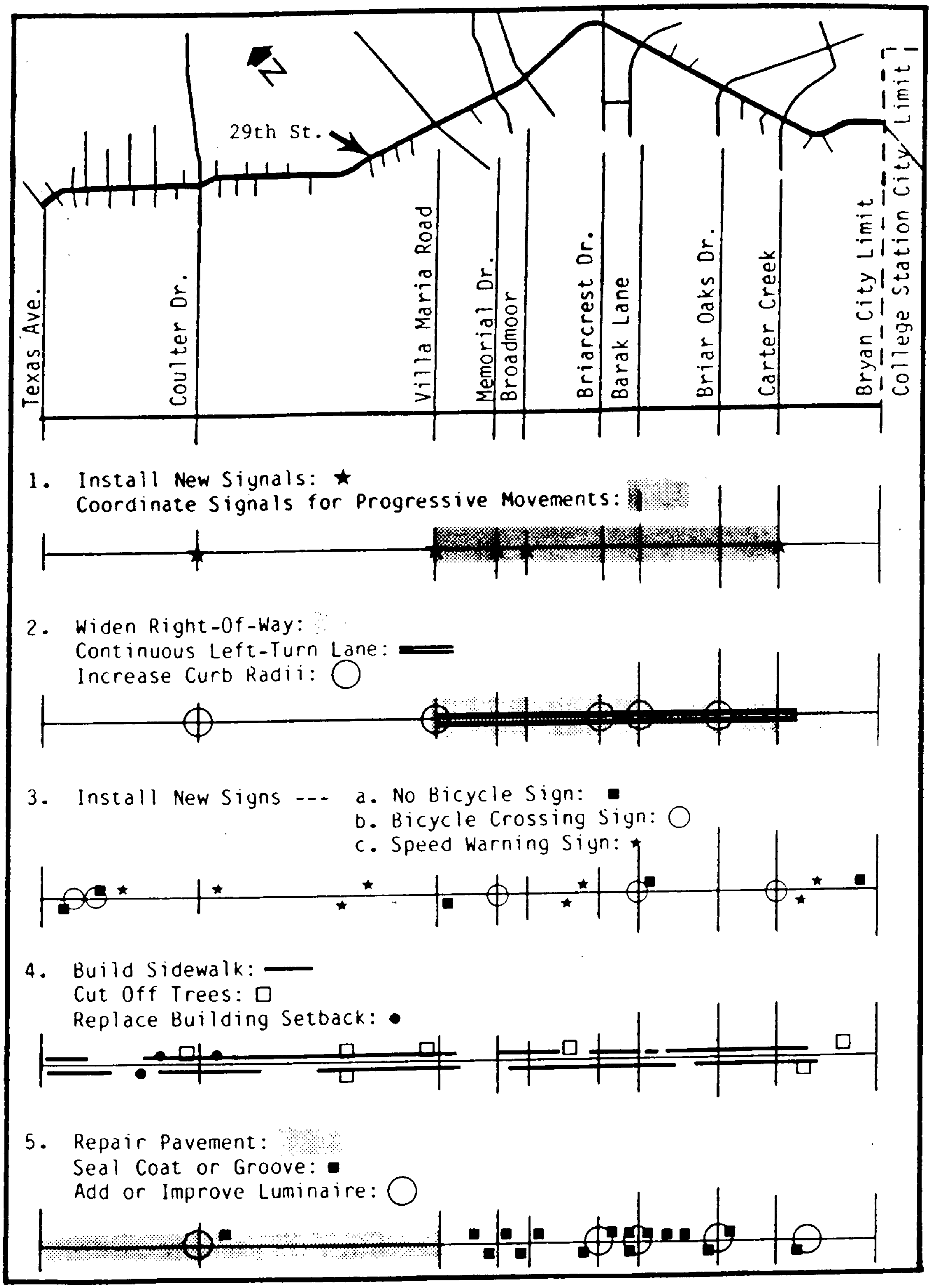


Figure V-10. Recommended action plan.

STEP 9. RECOMMEND AN ACTION PLAN

The recommended action plan for the 29th Street Corridor was basically a summary of the two initial action packages (see Fig. V-10). The cost of implementing the designed solution was approximately $2,000,000, which was expected to require a phased implementation period of 3 to 5 years. As a result, the corridor planning team grouped the recommended improvements into three logical stages for final engineering and construction. The first two stages covered improvements that were feasible for implementation in the first 2 or 3 years. The third stage might be implemented in Stage II if additional funds became available, but most likely would be implemented in the fourth or fifth year.

Stage I—($350,000):
- Install new or improved signals at major intersections.
- Coordinate signals.

Stage II—($1,100,000):
- Widen ROW.
- Add continuous left-turn lane from Carter Creek to Villa Maria Road.
- Increase curb radii at major intersections.

Stage III—($550,000):
- Install new sign and build new sidewalk.
- Add or improve lighting.
- Repair pavement.

SECTION VI

CASE STUDIES OF NCHRP Report 263

Six of the case studies described in Part III of *NCHRP Report 263* illustrate realistic applications of the step-by-step TSM process to site-specific planning situations. Although different approaches and methods were used in the studies, each contains the key features of the TSM process. The case studies are:

- Lisbon Street Corridor in Maine
- Community Transit in Alton, Illinois
- White Plains CBD Study in New York
- U.S. Route 7 Corridor in Connecticut
- Connecticut Park and Ride Lots
- St. Louis Regional Transit Assessment

CASE A. LISBON STREET CORRIDOR (PAGES 25–36 of NCHRP REPORT 263)

PURPOSE This case study illustrates the following:

- The nine-step TSM project planning process.
- The use of the Reference Handbook in that process.
- The standard format of the following case studies.
- The importance of careful problem assessment and of setting realistic design guidelines.

Step 1. Assemble and Review Information

The study was prompted by accident and congestion-related problems noted in ongoing monitoring of the city's arterial street system, and by complaints from Lisbon Street corridor residents and merchants about delays and unsafe driving conditions. City and state agencies flagged the corridor as probably needing improvement and conducted field observations, counted turning and through movement at intersections, made travel time runs, and compiled accident report data to provide information for a more rigorous assessment of existing conditions.

A. Study Strategic Management Activities

The principal guidelines were developed by project engineers and the task force overseeing the project. Limited financial resources ($200,000) were available for solving the problems; accordingly, guidelines for screening potential solutions with limited funds were provided:

- Limited physical improvements; no new or minimal additional ROW.
- Limited management actions; no institutional barriers.
- Limited operational actions; minimum of new traffic control equipment.

B. Analyze Existing and Anticipated Conditions.

- A 2-mile corridor connecting the Lewiston (Maine's) CBD with residential districts and a turnpike interchange.
- Two-lane major arterial.
- 5,000 to 8,000 ADT.
- Flanked by strip development.

Step 2. Analyze Problems and Their Setting

A. Collect Performance Data—B. Assess and Identify Problems

- Supply/Capacity—lane width under 11 ft
  —inadequate signs and pavement markings.
  —inadequate traffic control
  —curb turning radii less than 20 ft
  —sight distance problem at intersections
- Service Quality —intersection LOS lower than "C"
  —road segment LOS lower than "C"
  —peak travel speed under 20 mph
- Accidents—high accident rate along the corridor

C. Develop Graphical Representations

- Used "worksheet" in the analysis of intersections and road segments.
- Plotted to provide profiles of conditions along the corridor.
- Summarized the identified problems on the site map.
- Provided notes on the problem setting.

Step 3. Identify Candidate Strategies and Actions

The guidelines effectively limited consideration to traffic and parking operations and management improvements. Ridesharing and transit actions were considered inappropriate or ineffective and discarded, and physical improvements were ruled out by cost limitations. The Action Identification Tables 1 and 2 in the Reference Handbook were applied at this point to identify candidate strategies and actions.

Step 4. Screen Actions for Applicability and Effectiveness

The guidelines established for the project, site conditions, and professional judgment were used to screen the candidate strategies and actions for feasibility and effectiveness. The Action Profiles in the Reference Handbook were used to aid in the screening process.

The Action Screening Worksheet that was developed illustrates the screening process. The worksheet includes "candidate strategies/actions" cited in Action Identification Tables (e.g., separate traffic flows at intersections to reduce accidents and delays), "notes/comments" made by the project engineer and his staff (e.g., inadequate right-of-way), and courses of action, listed under "pursue?", as determined by the engineer (e.g., Yes, No, or Maybe).

Step 5. Specify Initial Action Packages for Analysis

- Package 1—New traffic control equipment and no new ROW.
- Package 2—New traffic control equipment and/or ROW.

Step 6. Plan the Analysis

A. Design and Evaluation Criteria

- Supply/capacity:
  Travel lanes at least 11 ft wide
  Standard signs, signals, and pavement markings
  Turning radii at least 20 ft
- Safety:
  Adequate separation between turning and through traffic
  Adequate buffer and safe crossing time for pedestrians
- Service quality:
  LOS "C" or higher
  Peak travel speed at least 20 mph
  Parking spaces within 300 feet of all stores
- Financial:
  Implementation budget limited to $200,000.

B. Analysis Plan

The analysis plan developed for the case study is diagrammed in Figure VI-1. The plan addresses all the evaluation factors and criteria. Problem setting and screening information were used to simplify the analysis where possible. The major simplifying factor was the absence of (1) significant growth in the corridor and (2) actions that might change travel patterns.

Step 7. Analyze Performance of Solution Packages

The Impact Estimation Aids section of the Reference Handbook contains (1) guidelines on selecting and applying estimation techniques and (2) tables that recommend specific techniques for common analysis situations. Since the design and operation of seven intersections, and of short segments between three pairs of these intersection, were key in solving the safety and delay problems, these locations were examined first. The principal "techniques" selected at the problem locations were:

- Examination of accident records and safety conditions.
- Application of adequate traffic engineering practice.
- Use of CMA and Webster's equation to test at LOS "C" or higher.

Step 8. Analyze Secondary Impacts of Solution Packages

A final check of signal phasing and timing was made to ensure no conflicts were introduced between intersections that could lead to delays and queues. Finally, state summaries of bid data were used to estimate final engineering and implementation costs.

Step 9. Recommend an Action Plan

- Stage I ($55,000); first 2 or 3 years.
- Stage II ($60,000); first 2 or 3 years.
- Potentially deferred ($75,000); fourth or fifth year.
- Prepared detailed diagrams of the recommended improvements.

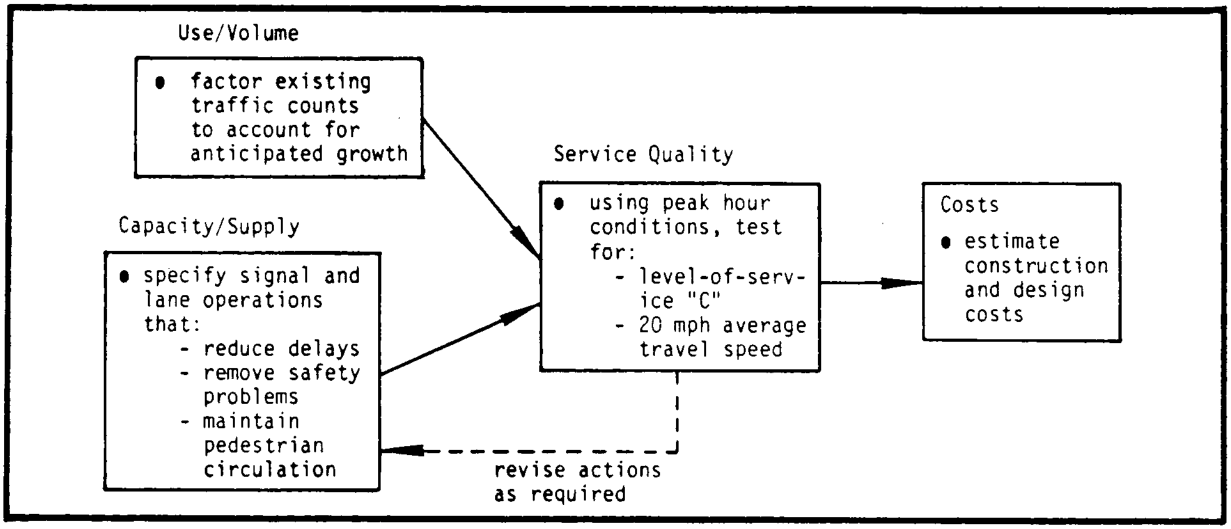


Figure VI-1. Example of analysis plan.

CASE B. COMMUNITY TRANSIT IN ALTON, ILLINOIS (PAGES 189–194 OF NCHRP REPORT 263)

PURPOSE This case study illustrates the use of analytical models to develop a substitute for regular route transit service. The objective was a reduction in the cost of providing intra-community service.

Step 1. Assemble and Review Information

Alton was selected as a possible site for a pilot service substitution project because of the following reasons:

1. A substrantial amount of local service.
2. Attractive site.
3. Earmarked sales taxes for transit.
4. Alternative federal operating assistance.

A. Study Strategic Management Activities

Guidelines set by the MPO led to the following specifications for the preliminary service options:

1. Existing service hours of 6:00 a.m. to 7:00 p.m.
2. Design headways of 30 minutes.
3. A separate service for school trips.
4. Main service areas to downtown Alton and the Alton Square Mall.

B. Analyze Existing Conditions

1. Three local routes operate from 6:00 a.m. to 7:00 p.m.
2. Headways range from 30 to 90 min covering about 7 sq mi.
3. Approximately 60 to 65 percent of Alton residents (pop. 36,000) within a quarter mile of a local route.
4. Scheduled wait times range from 13 to 28 min.
5. About 300 of the 700 daily passengers are school children.

Step 2. Analyze Problems and Their Setting

A. Collect Performance Data

See the Table on page 190 of *NCHRP Report 263* (Operating Statistics for Alton Local Routes).

B. Assess and Identify Problems

1. Some duplication of service.
2. Poor route productivity (high costs per passenger).
3. Poorly coordinated schedules for handicapped transfers to St. Louis service.

Step 3. Identify Candidate Strategies and Actions

1. Lower the basic hourly cost of providing service.
2. Increase the productivity in terms of trips served per hour.
3. Improve the level-of-service.

Steps 4 and 5. Screen Actions and Specify Initial Packages (Options)

The following service alternatives to the present Bi-State operation were specified as starting points for designing a community service:

- Option 1—A (revised) fixed-route operation.
- Option 2—A fixed-route operation that would allow riders paying a premium fare to request doorstep service within a reasonable distance of the route.
- Option 3—A door-to-door service such as shared-ride taxi.

Step 6. Plan the Analysis

Two possible decisions had to be accommodated:

1. Service levels could be held roughly unchanged, with a net savings in the total amount of subsidy required.
2. The reduced unit costs could be used to provide a slightly enhanced level of service, while maintaining the total subsidy at or slightly below present levels.

The analysis plan developed for the case study is diagrammed at the top of page 193 of *NCHRP Report 263.*

Step 7. Analyze Performance of Solution Package

The MMACS package, a computerized transit supply model which Multisystems developed for USDOT, was used to perform the analysis. The MMACS model showed that:

1. Vehicle requirements were extremely sensitive to headway.
2. Vehicle requirements could be significantly reduced by interlining between zones or by reducing coverage.
3. Sedan-type vehicles would be sufficient to serve the demand.

Step 8. Analyze Secondary Impacts

The estimates for Options 2 and 3 include telephone operators and additional dispatchers. Discounts to senior citizens were also included as part of the system modifications.

Step 9. Recommend an Action Plan

All three initial options appeared viable and compared favorably to current net costs. However, certain operating requirements that were new to the agency could be laid out to help final implementation planning for route deviation (Option 2) and demand-responsive service (Option 3).

Route Deviation

- A premium fare of 50 cents per deviation should be charged.
- An operator to receive telephone requests would be required.

Cycled Demand-Responsive or Shared-Ride Taxi

- The fare should probably be set at $1.00 or higher.
- Several operators, dispatchers, and starters would be required.

****
*** Short Quizzes for Self-Evaluation *** (Answers on page 33)
****

26. The Technical Notes #____ and #____ on pages 142–164 of NCHRP Report 263 might be applied to calculate performance indicators and to estimate annual operating costs.

27. What TSM Action Profiles on pages 59–112 of NCHRP Report 263 might be used to screen actions and to specify initial packages as starting points for designing a community service?

****

CASE C. WHITE PLAINS CBD STUDY (PAGES 195–199 OF NCHRP REPORT 263)

PURPOSE This case study involves coordinated efforts to improve traffic, transit, and pedestrian operations in the CBD of a small city.

Step 1. Assemble and Review Information

A. Analyze Existing and Anticipated Conditions

The study was prompted by the City's transportation officials who recognized that continued economic growth depended heavily on convenient access to and circulation within the CBD by all modes.

B. Study Strategic Management Activities

A downtown comprehensive transportation plan was commissioned to improve mobility and reduce existing and anticipated congestion. Key steps in identifying and analyzing problems included:

1. *Agency meetings* held with traffic, parking, planning, transit, and development officials to identify problems, define goals, and denote opportunities.
2. *Field observations* made to collect traffic data and to discover operational problems.
3. *Transportation and development reports* from the previous 15 years reviewed for data, previous recommendations, and current relevancy.

Step 2. Analyze Problems and Their Setting

A. Collect Performance Data

1. Existing traffic volumes were analyzed to identify capacity problems. Seven of the 28 portals were identified as nearing or at capacity. (See "Daily Traffic" on page 196 of *NCHRP Report 263.*)
2. Bus transportation was assessed to determine route coverage (bus stop locations) and the system's ability to carry rail passengers from rail stations to the CBD.
3. Parking capacity and occupancy were analyzed. A parking shortage was likely to occur in specific areas within 5 years.
4. Pedestrian flows were also studied. The major shortcoming noted was a lack of sidewalks connecting the area of primary pedestrian activity with a large retail shopping complex.
5. An analysis of taxi service indicated the major demand generators.

B. Assess and Identify Problems

1. Vehicle conflicts with parked cars, buses, and pedestrians.
2. Traffic congestion.
3. Limited street capacity.
4. Limited short-term parking.
5. Pedestrian circulation void.

C. Develop Graphical Representations

The locations of these problems were mapped, as shown on page 197 of *NCHRP Report 263.*

Steps 3 and 4. Identify Candidate Strategies and Screen Actions

Candidate strategies and actions were identified and screened using the following criteria:

1. Coordinate transport facilities and capacities.
2. Catalyze developments by improving existing facilities.
3. Maintain and maximize accessibility of the city center.
4. Provide travelers with choice of mode and route.
5. Encourage public transport ridership.
6. Provide a balance of long-term and short-term parking facilities.
7. Expand capacity across the major barriers to movement.
8. Develop a cohesive CBD by making intra-CBD movements easy.
9. Refine bus routes.
10. Coordinate rail, parking, pedestrian, and transit proposals.
11. Encourage and assist paratransit facilities.

Step 5. Specify Initial Packages

1. *Street Improvements:*
   a. Improve circulation throughout the city.
   b. Expand capacity at major gateways without adding additional traffic to neighborhood streets.
   c. Increase intersection and segment capacity to assess one-way street pairs and minor intersection improvements.

2. Transit and Pedestrian Improvements:
   a. Transform an existing street into a two-block "bus-only" street in the heart of a shopping district.
   b. Close a street.
   c. Construct new street segments.

Step 6. Plan the Analysis

To verify the feasibility of proposed actions, traffic flow and volume maps were prepared for the year 2005 using manual assignments of estimated traffic.

Steps 7 and 8. Analyze Performance of Solution Package and Secondary Impacts

The proposed CBD traffic flow patterns would accommodate a 30 percent increase in peak-hour traffic with only three new street segments. The increases in eastbound right turns from Main onto Court (resulting from transferring 250 cars to this intersection during the peak hour) and the impacts of these right turns on pedestrian flow were analyzed. Because most pedestrians were oriented to the midblock mall rather than the Main Street, the conflicts were believed manageable. Future transit operations and curbside usage were also forecast and mapped. (See the figure "Bus Lane" on page 198 of *NCHRP Report 263.)*

Step 9. Recommend an Action Plan

Roadway and traffic improvements for the CBD were recommended to provide an integrated system of street, bus, parking, and pedestrian facilities. A general three-stage construction plan was established as follows:

Stage I—(1982-1984):
   a. Alleviate major capacity restrictions.
   b. Improve public transit.

Stage II—(1985-1987):
   a. Begin construction projects.
   b. Make improvements to the downtown circulation system.

Stage III—(1988-1991):
   a. Complete street extensions.
   b. Complete the skywalk system.

****
*** Short Quizzes for Self-Evaluation *** (Answers on page 33)
****

28. Action Identification Tables # __ and # __ on pages 42–58 of NCHRP Report 263 could be applied to identify general approaches for potential solutions.
29. Method Selection Aid # __ on pages 117–141 of NCHRP Report 263 might be used to estimate the traffic flow and volume for the year 2005.

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CASE D. ROUTE 7 CORRIDOR IN FAIRFIELD (PAGES 200–205 NCHRP REPORT 263)

PURPOSE This study illustrates TSM in a corridor where major new land developments are proposed. It is very similar to the 29th Street Corridor Study discussed in Section V.

Step 1. Assemble and Review Information

The TSM study of the Route 7 Corridor was conducted in response to traffic congestion, accidents, and conflicts caused by substantial new commercial development.

A. Study Strategic Management Activities

The Connecticut Department of Transportation (ConnDOT) had proposed a parallel expressway to alleviate these problems;

however, this project was deferred because of costs and community concerns. Subsequently, the communities affected by these problems voiced their preference for traffic management and engineering actions to provide immediate relief, especially as land development continued. The study was commissioned by the Southwestern Regional Planning Agency (SWRPA) in cooperation with ConnDOT, the City of Norwalk, and the Town of Wilton.

B. Analyze Existing and Anticipated Conditions

The site for the study was a 10.2-mile corridor extending about 0.5 miles east and west of Route 7, a two-lane roadway running north-south and carrying over 20,000 vehicles per day. It is flanked by new and proposed commercial development. The remaining land use in the corridor is a low density residential area with pockets of higher density development.

Step 2. Analyze Problems and Their Setting

A. Collect Performance Data

Roadway geometrics and characteristics were assessed, and data were collected on traffic characteristics, speed and delay, parking, and pedestrian volumes. Strip maps were then prepared to illustrate peak-hour and midday travel conditions along Route 7. In addition, the hourly distribution of vehicles was graphed (see page 201 of *NCHRP Report 263*).

B. Assess and Identify Problems

1. *Roadway Geometrics:*
   a. Eighteen horizontal curves greater than 6 deg.
   b. Forty locations where sight distance is less than 400 ft.
   c. Only one location where passing sight distance is greater than 1,700 ft.
   d. An at-grade railroad crossing where over 15 trains pass daily.

2. *Service Quality of the Existing Traffic Operations:*
   a. Narrow lane width and limited number of lanes.
   b. Existing volumes exceeded service capability of a two-lane road.
   c. Narrow offset cross streets, complicated intersection geometry, increased left-turn volumes, and limited approach capacities.
   d. Numerous corporate parks and commercial developments created extremely high peak-period traffic volumes.

3. Anticipated traffic conditions also were derived and assessed. The hourly traffic volume of 3,360 was derived during AM-peak periods. Traffic volumes were forecast to more than triple the existing volumes on certain segments within the next 5 years. The forecast further indicated that existing congestion and queuing problems would become more acute as development continued.

C. Develop Graphical Representations

The principal problem locations, including queues during peak periods, were highlighted on a strip map (see page 202 of *NCHRP Report 263*). Anticipated peak-hour trips were shown on page 203 of *NCHRP Report 263*.

D. Sketch a Plan

The initial intent of the study was to identify and design low-cost improvements; however, a review of the problems warranted looking beyond management actions. Public officials and community groups decided to expand the transport capacity.

Step 3. Identify Candidate Strategies and Actions

1. Make minor adjustments to improve traffic flow efficiency.
2. Expand transit service and facilitate ridesharing and alternative work schedules to reduce traffic volumes.
3. Develop a parallel route to divert traffic and expand capacity.
4. Widen and improve the existing Route 7.

Steps 4 and 5. Screen Actions for Applicability and Specify Initial Packages

Screening the potential actions resulted in a determination that the only candidate strategy that would provide some immediate improvement to the capacity problem was to *widen and improve the existing Route 7.* Hence, with only one candidate solution, one initial package was also completed.

Step 6. Plan the Analysis

All specific improvements were analyzed according to their abilities to improve signal operations, increase capacities, and reduce delays. The coordination of signals along specific sections of Route 7 was planned. Cross-section and right-of-way standards were developed and used to estimate right-of-way requirements and construction costs.

Step 7. Analyze Performance of Solution Packages

Proposed improvements included roadway widening, left-turn lane additions, intersectional improvements, and signal coordination. The locations of these improvements are shown on page 205 of *NCHRP Report 263*. Supportive actions were identified to encourage employers to adopt both ridesharing efforts and alternative work schedules, and to encourage transit ridership.

Step 8. Analyze Secondary Impacts

Along with the roadway widening proposal, additional roadway benefits were recognized, including drainage system improvements, street lighting, new signs, sidewalks, underground utilities, and landscaping.

Step 9. Recommend an Action Plan

The construction costs for the recommended improvements were estimated at $16 million. A three-stage development plan emphasizing the improvements that would alleviate the capacity problem was suggested:

Stage I—Favor improvements that would alleviate major current system capacity constraints and deficiencies.

Stage II—Favor improvements that would not merely transfer problems.

Stage III—Provide a reasonably even distribution of costs among the various program stages.

****
*** Short Quizzes for Self-Evaluation *** (Answers on page 33)
****

30. A segment between ________ Ave and _____ _____ Rd is anticipated to have the highest peak-hour traffic volume generated by new development. (See the figure "Anticipated Peak-Hour Traffic" on page 203 of NCHRP Report 263.)
31. What TSM Action Profile on pages 59–112 of NCHRP Report 263 is not used to identify candidate strategies and actions?
    a. Profile 1 b. Profile 11 c. Profile 21 d. Profile 32

****

CASE E. CONNECTICUT PARK-AND-RIDE LOTS (PAGES 206–208 OF NCHRP REPORT 263)

PURPOSE This case illustrates how the TSM decision-making process can be used to determine prime locations for park-and-ride lots and to guide the detailed siting and development of specific lots.

Step 1. Assemble and Review Information

A. Study Strategic Management Activities

Connecticut's Commuter Parking Program originated in 1969 with a study of all expressway interchanges in the State to determine the location, the amount, and characteristics of commuter park-and-ride activities. The Connnecticut Department of Transportation (ConnDOT) has implemented this program throughout the State:

1. To accommodate dispersed commuting patterns and long work trips without further expanding facilities.
2. To respond to air quality and energy conservation concerns.
3. To solve localized safety and traffic flow patterns caused by roadside parking.

B. Analyze Existing and Anticipated Conditions

By the end of 1981, about 160 lots were in operation. The lots offered nearly 13,000 spaces for carpoolers and express bus riders, and 75 to 80 percent were filled on the average.

Step 2. Analyze Problems and Their Setting

A field inspection indicated that over 800 vehicles were parking, often illegally and haphazardly, at 83 different locations. In 1976, prepaid postcards, placed on the windshields of these vehicles, requested the owner to inform ConnDOT of their destinations. The results indicated that most parkers were making a work trip, that their average trip distance was 36 miles, and that their primary destinations were Hartford, New Haven, and Stamford. Obviously, the problem was the need for park-and-ride lots.

Step 3. Identify Candidate Actions

ConnDOT strives to obtain low-cost sites for their park-and-ride lots that will be well used. Hence, candidate actions involved finding these cost-effective sites.

Step 4. Screen Actions for Applicability

To help screen potential sites, ConnDOT has developed a computerized program based on the results of the windshield survey conducted in 1976. Responses to the survey indicated that most users parked within 10 min of their homes, with very few driving more than 20 min. (See "Trip Length Distributions" on page 207 of *NCHRP Report 263.*) The computerized screening process lists the number of potential lot users that would be using a park-and-ride lot. The program has proven to be very effective.

Step 5. Specify Initial Packages for Analysis

The results of the computerized analysis provided the most cost-effective sites for park-and-ride facilities.

Step 6. Plan The Analysis

Initially, the speed at which a lot could be constructed was emphasized as the most important factor. Now the analysis requires more effort because of the increased complexity of design and construction techniques. Standard specifications and design criteria have helped to expedite implementation.

Step 7. Analyze Performance of Solution Packages

ConnDOT's computer program provides an estimate of the use of a proposed park-and-ride lot. However, actual investigation of a lot is the only accurate procedure for identifying its success. Current lots are used to about 80 percent of capacity, an excellent rate.

Step 8. Analyze Secondary Impact

Construction of park-and-ride lots encourages park-and-ride activity, which helps to conserve energy and reduce roadway capacity. Removal of parked vehicles near the interchanges results in a safer operational condition and a more aesthetically pleasing site.

Step 9. Recommend an Action Plan

Once site selection and planning have been accomplished, ConnDOT begins the review process for construction. Time required to begin review, obtain approval, and construct the lot varies from 12 to 18 months.

****
* **Short Quizzes for Self-Evaluation** * (Answers on page 33)
****

32. TSM Action Profile # __ on pages 59–112 of NCHRP Report 263 could be used to determine prime locations for Connecticut park-and-ride lots.

****

CASE F. ST. LOUIS REGIONAL TRANSIT ASSESSMENT (PAGES 184–188 OF NCHRP REPORT 263)

PURPOSE This case study illustrates adaptation of different TSM approaches and methods from the nine-step TSM decision-making process used in the previous case studies. it illustrates the use of **strategic planning** in an urban area faced with **problems in financing** public transit operations.

This case was unique because it examined transit service policy options used to help government leaders, and transit operators set realistic guidelines for transit service planning. A two-phase study was initiated. Phase 1 was an overall evaluation of transit service in the Region. Phase 2 focused on alternative service and financial strategies.

Estimating Fiscal Resources and Requirements

Proposed fiscal reductions threatened to produce operating deficits that would force Bi-State to make major service reductions and/or significant fare increases. Different levels of federal support and sales tax revenue were projected and used to develop forecasts. (See the figure "Expense and Revenue Forecasts" on page 184 of *NCHRP Report 263.*)

Assessing Service Adequacy

An aggregate analysis of existing transit service was conducted to assess overall service adequacy and equity. For the analysis, the region was divided into 18 districts, as shown on page 185 of *NCHRP Report 263*. The following three sets of measures were developed for each district:

1. Indicators of service need:
   a. Combined population and employment density.
   b. Percent of residents in low-income households.
   c. Percent of residents in auto-less households.
   d. Percent of residents under 16 or over 65.
   e. Percent of residents in minority groups.

2. The quantity and quality of service:
   a. Vehicle-hours, vehicle-miles, and route-miles.
   b. Travel time to CBD during peak hours.
   c. Average peak speed, headway, and vehicle load.
   d. Number of bus trips to major destinations during peak hours.
   e. Coverage (%) of population within ¼ mile of route.

3. The use of existing service:
   a. Boardings per vehicle-hour.
   b. Boardings per capita.

Analyzing Service Revision Options

The assessment of service highlighted some inequities and inefficiencies in the region's transit service. The following basic options for reducing the forecast deficit were examined for their ability to solve the problems:

1. Reduced hours of operation.
2. Reduced service frequency.
3. Reduced coverage by consolidating routes.
4. Dropped or replaced service.
5. Increased fares.

Service revisions were evaluated primarily according to two summary measures:

1. Effectiveness—net annual cost savings.
2. Efficiency—net cost savings per passenger lost.

Graphs of the evaluation measures indicated that all five candidate actions would result in cost savings. (See the figure "Summary Evaluation Measures" on page 188 of *NCHRP Report 263.*)

Recommendations

Final recommendations were inconclusive because of questionable financial support from Washington and untested proposed strategies. However, some pilot programs were initiated to improve transit service productivity and efficiency. These pilot programs included:

1. Route revisions and bus lanes in downtown St. Louis.
2. Restructuring of suburban express service in a corridor.
3. Replacement of low-volume routes with paratransit service.

****
* Short Quizzes for Self-Evaluation * (Answers on page 33)
****

33. This case study illustrates the use of ________ planning which covers not only the programming of recommended projects, but also the setting of realistic ________ for design and development so projects can be ______ and ______ without excessive delays. (See pages 6–13 of NCHRP Report 263.)
34. The Technical Note # __ on pages 142–164 of NCHRP Report 263 could be applied to estimate changes in vehicle-miles, vehicle-hours, and number of buses, and the Technical Note # __ was applied to estimate changes in ridership and revenues.
35. E/P (Evaluation and Packaging) Note # __ on pages 166–178 of NCHRP Report 263 were applied in this case study to compare and evaluate the service revision options.

****

******** ANSWERS for SECTION IV ********

1. Transportation Systems Management, existing, efficiently, practical, low-cost, short-range
2. C
3. A. Action
   B. Profiles
   C. Package
   D. Strategy
   Step 1: Information
   Step 2: Problems
   Step 3: Strategies, Actions
   Step 4: Screen
   Step 5: Packages
   Step 6: Plan
   Step 7: Solution Package
   Step 8: Impacts
   Step 9: Recommend
5. strategic management
6. True
7. Plots
8. worksheets
9. False
10. strategies, actions
11. Action Identification
12. Screened
13. Action Profiles
14. True
15. True
16. Performance measures
17. Intermeasures
18. dir, dir, dir, der, der, der, int, int
19. Cost, effectiveness, benefit, cost
20. True
21. True
22. planners, engineers
23. implementable
24. staging
25. iteration

******* ANSWERS for SECTION VI ********

26. Tech. Note **4:** Transit Supply Estimation Procedure and Tech. Note **5:** Transit Service and Fare Elasticities.
27. Profile 32: Expanded Regular-Route Bus Service; Profile 35: Shared-Ride Taxi; and Profile 37: Community Transit Service.
28. Action Identification Table **4:** Problems at Employment Centers; and Action Identification Table **5:** Problems at Commercial Centers.
29. Method Selection Table **4:** Travel Estimation.
30. Glover, West Rocks.
31. b. Profile 11
    a. Profile 1: Staggered Work Hours.
    b. Profile 11: Parking Rate, Fine, and Time Limit Adjustments.
    c. Profile 21: Signal Phases for Left Turns.
    d. Profile 32: Expanded Regular-Route Bus Service.
32. Profile 7: Park-and-Ride Lots Along Transit Routes.
33. strategic, guidelines, funded, implemented.
34. Tech. Note **4:** Transit Supply Estimation Procedure and Tech. Note **5:** Transit Service and Fare Elasticities.
35. E/P Note **3:** Cost-Effectiveness and Benefit/Cost Analysis.

APPENDIX A

CORRECTION OF PAGE 92 OF NCHRP REPORT 263

Note: Some early printings of *NCHRP Report 263* had errors in the Blue Section Profile 25, page 92. The corrected version of the page is included herein.

Profile 25: Employer Vanpool Program

An employer may benefit (through reduced parking requirements or easier recruitment of employees) from an extensive use of ridesharing. One option for accomplishing this is to provide financial support to employees willing to form or operate vanpools. This support may occur in the form of financing an employee's or group's purchase of a commuting van, the assignment of a van owned or leased by the company to a group of commuters, or other arrangements that subsidize or pass volume discounts through to commuters using vans to commute in groups of 8 to 12.

Problems Addressed:

- Peak period congestion on roads in, near, or approaching an employment center is expected to increase if business expansion plans are approved and implemented.
- Changes in worksite or reductions in transit service are expected to increase commuting costs of employees.

Conditions for Application:

- Long commutes—The time spent collecting or assembling the 8 to 12 people for a vanpool will deter most commuters from joining. In general, the best market for vanpools is among commuters traveling more than 15 miles or 40 minutes in each direction.
- Large employers—Firms or government agencies employing 2000 or more workers with regular schedules are the best prospects for the action, although smaller firms may have sufficient concentrations of employees commuting long distances to support this action.
- Management commitment—Many employees forming or joining a vanpool will be making a significant investment decision, so they may hesitate until it is clear that top management has made a long-term commitment to support and encourage the action.
- Limited transit availability—If many long distance commuters have the option of convenient express bus service, the action is likely to attract few users.

Potential Implementation Problems:

- Vehicles codes, motor carrier regulations, and driver qualification requirements rule out or impede the operation of vanpools in many states.
- Insurance covering the employer's and driver's liabilities may be difficult or expensive to obtain.
- The responsibility of operating and maintaining a van is likely to fall on one or a few individuals, so a program should allow for equitable compensation.

Potential Evaluation Factors:

- Mode shift (the means of accomplishing other objectives):
  —change in vehicle volumes entering (AM) or leaving (PM) center during peak commuting periods
- Administration:
  —costs of acquiring the vans and setting up the program
  —annual cost of supporting and administering the action

References:

(1) Multisystems and Skidmore, Owings and Merrill, "Ridesharing Implementation Guide," developed for USDOT/FHWA under Contract DTFH61-80-C-00182 (1981) 150 pp.

A detailed guide for setting up and running a corporate ridesharing program. A program at AETNA Life and Casualty (Hartford CT) is presented as a case study.

(2) USDOT, "How Ridesharing Can Help Your Company, a Manual for Employers" (May 1980) 47 pp.

Discusses key issues in setting up a program, and provides cost data on several employer programs.

(3) Misch, M.R., et. al., "Guidelines for using Vanpools and Carpools as a TSM Technique," *NCHRP Report No. 241,* Washington DC (December 1981) 155 pp.

Discusses applicability, planning, design and implementation issues, and packaging with complementary TSM actions.

(4) New York State Energy Office and DOT, "A Guide to Vanpooling in New York State," Albany NY (undated) 80 pp.

A manager's guide to setting up a vanpool program.

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