National Cooperative Highway Research Program

NCHRP Synthesis 201

Multimodal Evaluation in Passenger Transportation

A Synthesis of Highway Practice

Transportation Research Board
National Research Council

National Cooperative Highway Research Program

Synthesis of Highway Practice 201

Multimodal Evaluation of Passenger Transportation

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PREFACE

A vast storehouse of information exists on nearly every subject of concern to highway administrators and engineers. Much of this information has resulted from both research and the successful application of solutions to the problems faced by practitioners in their daily work. Because previously there has been no systematic means for compiling such useful information and making it available to the entire highway community, the American Association of State Highway and Transportation Officials has, through the mechanism of the National Cooperative Highway Research Program, authorized the Transportation Research Board to undertake a continuing project to search out and synthesize useful knowledge from all available sources and to prepare documented reports on current practices in the subject areas of concern.

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

FOREWORD

By Staff
Transportation
Research Board

This synthesis will be of interest to transportation planners, environmental analysts, and government officials at the federal, state, regional, and local levels. It describes the state of the practice with respect to the procedures and methodologies used by planning agencies at all levels to plan and evaluate alternative multimodal passenger transportation and to integrate these plans with related land use and environmental issues.

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

This report of the Transportation Research Board describes the federal studies and guidelines that are available and presents the findings of an extensive survey of state, regional, and local agencies to identify the evaluation methods that are being used in the practice. Selected case studies for five types of modal evaluation are presented: intercity corridor, regional study, regional screening, urban corridor, and regional programming.

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

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

CONTENTS

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Valuable assistance in the preparation of this synthesis was provided by the Topic Panel, consisting of Linda Bohlinger, Director of Capital Planning and Programming, Los Angeles County Transportation Commission; Donald J. Emerson, Chief, Planning Analysis and Support Division, Federal Transit Administration, U.S. Department of Transportation; George Gundersen, Director, Bureau of System Planning, Wisconsin Department of Transportation; Charles E. Howard, Manager of Transportation Planning Office, Washington State Department of Transportation; Michael D. Meyer, Professor, Georgia Institute of Technology; Clyde E. Pyers, Director, Office of Policy and Planning, Maryland State Highway Administration; George E. Schoener, Chief of Intermodal Division, Federal Highway Administration, U.S. Department of Transportation; James A. Scott, Transportation Planner, Transportation Research Board; Edward Weiner, Senior Policy Analyst, U.S. Department of Transportation, Office of the Secretary of Transportation; and George V. Wickstrom, Metropolitan Washington Council of Governments, (Retired).

The Principal Investigators responsible for the conduct of this synthesis were Sally D. Liff, Manager, Synthesis Studies, and Stephen F. Maher, Senior Program Officer. This synthesis was edited by Linda S. Mason.

Scott A. Sabol, Program Officer, National Cooperative Highway Research Program, Transporation Research Board, provided valuable assistance to the Topic Panel and the Project 20-5 staff.

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

MULTIMODAL EVALUATION IN PASSENGER TRANSPORTATION

SUMMARY

Several states, metropolitan areas, and federal agencies increasingly have been undertaking planning and programming activities that require the evaluation of multimodal alternatives. The alternatives analysis requirement of the Federal Transit Administration (FTA) and, to some extent, the environmental impact statement (EIS) requirement of examination of all reasonable alternatives, provide a starting point for multimodal consideration of alternative transportation systems. However, in many cases, the alternatives are defined within the same mode, such as bus versus light rail or arterial versus freeway expansion. Seldom is there an objective and comprehensive comparison of different modes, e.g., building a light-rail line versus expanding a major freeway or expanding an airport versus improving rail service. Yet, increasingly, these are exactly the types of decisions that transportation officials are being asked to make, particularly because of more flexible funding. Apparently, no document is available to planners for information on how to perform multimodal evaluation; such a document needs to be developed.

This document presents information on the state of the art in multimodal evaluation for planning and programming based on information gathered in 1991 and 1992. Sources include mail survey responses of state Departments of Transportation (DOTs), Canadian provinces, and regional governments, as well as a literature search. As expected, this information-gathering process uncovered few good examples of multimodal planning and programming evaluation, a result that reflects the largely inflexible modal funding process in place prior to the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 and the slow process of change in transportation planning procedures.

Three major federal efforts in multimodal evaluation are reviewed in this synthesis, along with 18 state, regional, and corridor projects that were uncovered in the survey process. Five of the surveyed projects were developed into case studies that reflect current practice in intercity, regional, and urban corridor evaluation. An extensive review of evaluation criteria and measures of effectiveness is provided.

This synthesis concludes that new training, assistance, and guidelines for multimodal evaluation should be provided at the national level, with an emphasis on updating and expanding existing resources. It also concludes that effective multimodal evaluation is hindered by the lack of a commonly accepted multimodal measure of mobility.

CHAPTER ONE

INTRODUCTION

The Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 established the nation's transportation program for the following 6 years (*1*). The ISTEA created a surface transportation program with funding that may be used flexibly among highway and mass transit projects. This new flexibility has created the need to establish procedures to evaluate multimodal investments in transportation projects.

This National Cooperative Highway Research Program (NCHRP) synthesis project was established to survey current practice in comparing different modes of transportation. For the purposes of this study, multimodal refers to comparisons among alternatives, such as the addition of general purpose highway lanes versus light rail or the expansion of an airport versus high-speed rail. Bus-rail comparisons are well documented as part of the Federal Transit Administration's (FTA's) alternatives analysis process.

Various states, Canadian provinces, and metropolitan planning organizations (MPOs) were surveyed to discover examples of multimodal evaluation. Chapters 3 and 4 of this synthesis document the survey results.

Interest in multimodal planning and evaluation dates back well beyond the ISTEA of 1991. In 1974, Frederick Frye conducted a study for NCHRP that surveyed experiences with planning evaluation, and he proposed an economic framework for evaluation (*2*). Among his specific conclusions, Frye recommended that criteria be applied uniformly to all modes.

In 1979, Bellomo et al. completed a study for the NCHRP that proposed the following research to address programming issues (*3*):

> . . .develop and apply a methodology for the evaluation of candidate multi-modal programs that [would provide], insofar as [was] practical in the operational context, the following desirable characteristics: (1) *common evaluation measures across different modal programs to facilitate comparisons and tradeoffs*, (2) comprehensive treatment of the most important factors involved in programming, (3) information of importance to all those involved in programming decisions (e.g., state budget office, governor's office, legislature, and top officials of transportation agencies), and (4) effective use of available data and techniques. [emphasis added]

The two NCHRP reports by Frye and Bellomo both suggest that good multimodal planning and programming should employ evaluation criteria that are also multimodal.

A recent study by the Transportation Research Board (TRB) on high-speed rail options for the United States concluded the following (*4*):

> It is clear that the United States does not have the institutional and financial mechanisms to evaluate HSGT [high-speed ground transportation] alternatives within the context of a national transportation system. U.S. institutional and financial arrangements for transportation are oriented toward existing modes, making it difficult to introduce a new mode.

During the 1992 TRB summer planning meetings in Seattle, Michael Meyer, a keynote speaker, talked about the need for "jumpstarting the push toward multimodalism" (*5*). In his speech, Meyer discussed the requirements and potential impacts of the new ISTEA, which could allow two-thirds of all ISTEA funds to be allocated to transit. He pointed out that the following factors would likely prevent that from happening:

- The traditional modal orientation of agencies,
- Restrictions on use of state and local revenues for matching new flexible funds,
- The separation of the modeling process by modes, making trade-offs difficult, and
- The infrequent consideration of goods movement.

Meyer also noted recent workshops at which the need for true multimodal planning was discussed, including the Urban Mass Transportation Administration (UMTA)/American Public Transit Association (APTA) 1991 workshop on "Fixed Guideway Planning." A 1992 conference sponsored by the Federal Highway Administration (FHWA) also highlighted the need for additional development of our capability in multimodal planning (*7*).

The General Accounting Office's (GAO's) 1992 report on transportation planning concluded generally that little multimodal planning is being undertaken and specifically that multimodal criteria for planning and programming need to be developed (*8*).

The experiences documented previously highlight the need for a better understanding of the state of the art in multimodal planning and programming evaluation. This NCHRP project was funded to obtain this information. The following chapters review federal guidelines and suggestions as well as the results of a survey of current practice in multimodal evaluations. Additionally, this synthesis details case studies and lists conclusions and recommendations.

The case studies that follow reflect evaluations carried out for different purposes at various levels of detail and effort. The case studies range from simple screening of many alternatives to detailed corridor studies representing major capital expenditures.

CHAPTER TWO

FEDERAL STUDIES AND GUIDELINES

In the past 15 years, the federal government has sponsored several important studies and developed guidelines relating to the evaluation methods and criteria. In 1978 the Assistant Secretary for Policy and International Affairs in the U.S. Department of Transportation (US DOT) published *Evaluating Urban Transportation System Alternatives* by Cohen, Stowers, and Petersilia (*9*). This document provides a comprehensive overview of much of the literature covering transportation evaluation measures and many of the methods used at that time. In 1979 FHWA published *Measures of Effectiveness for Multimodal Urban Traffic Management* by Abrams and DiRenzo (*10*). This document reviews measures of effectiveness for multimodal transportation management. Finally, in 1986 the UMTA, now the FTA, first published its guidance on the analysis of fixed guideway transit projects (*11*).

Table 1 summarizes the criteria discussed in the three federal documents; details of each study are shown in Tables 2, 3, and 4, respectively. Table 1 shows that the FTA's alternative analysis guidelines imply a complete range of evaluation criteria, but not all alternative analysis projects under these guidelines have used all of these measures. Because the FTA's alternative evaluation process includes an EIS, a broadened set of criteria is much more likely. A larger set of criteria also ensures a much more detailed evaluation process. A typical set of criteria used in the FTA alternatives analysis process is shown in Table 3.

The 1978 US DOT study by Cohen, Stowes, and Petersilia concentrated on quantification of as many evaluation criteria as possible and provided an excellent overview of methods for calculating impacts and alternatives (*9*). Table 2 lists the criteria and measures developed as part of this process.

In the FHWA study, Abrams and DiRenzo provide great detail on possible evaluation criteria and measures for the evaluation process (*10*). Table 4 briefly summarizes the findings in that report. The report is useful for determining measures of effectiveness for transportation evaluation.

The ISTEA of 1991 established 15 transportation planning factors for metropolitan areas and 20 for statewide planning. Table 5 lists the metropolitan planning factors. Though these factors are not meant to be evaluation criteria, they do provide guidance in the development of criteria. The following factors are not currently considered in the criteria categories identified for this report:

Factor	New Evaluation Category
1	Preservation
5	Enhancement Activities
9	Management Systems Requirements
10	Right-of-Way Preservation

New criteria and measures will need to be developed for these factors so that the multimodal evaluation process is responsive to the ISTEA.

TABLE 1
SUMMARY OF MAJOR FEDERAL EVALUATION DOCUMENTS

Criteria Category	1978 US DOT	FTA's Alternatives Analysis Guidelines[1]	1979 FHWA Abrams and DiRenzo[2]
1. Transportation System Performance	2	4	13
2. Mobility	—	1	2
3. Accessibility	—	2	2
4. System Development, Coordination and Integration	—	2	—
5. Land Use	—	4	—
6. Freight	—	2	—
7. Socioeconomic	2	5	4
8. Environmental	2	5	2
9. Energy	—	1	1
10. Safety and Security	1	2	2
11. Equity	—	2	2
12. Costs and Cost-effectiveness	11	4	7
13. Financial Arrangements	—	3	—
14. Institutional Factors	—	1	—
15. Other	—	1	—

Note: [1]Specific criteria are not listed in FTA guidelines. This list was developed to represent a typical study.
[2]This study lists additional criteria measures not used in this summary.

TABLE 2
EVALUATION CRITERIA SUGGESTED BY THE 1978 US DOT STUDY

General Category	Criteria[1]	Measures
1. Transportation System Performance	Highway level of service	A - F[2]
	Transit use	Ridership[2]
2. Mobility	—	—
3. Accessibility	Note[3]	—
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	Social	Description[4]
	Construction disruption	Description[4]
8. Environmental	Air quality	% reduction of emissions[2]
	Noise	Areas with 80 dB or more[2]
9. Energy	—	—
10. Safety and Security	Accidents	Dollars saved[2]
11. Equity	—	—
12. Costs and Cost-effectiveness	Travel time savings	Dollars[2]
	Vehicle operating savings	Dollars[2]
	Transit operating costs	Dollars[2]
	O and M for highways	Dollars[2]
	Capital costs	Dollars[2]
	Net benefits[5]	Dollars[2]
	Total cost/daily person miles of travel	$/PMT[2]
	Capital cost/hour of daily time savings compared to doing nothing	$/hour[2]
	Additional jobs accessible within 30 minutes/$1000 of project cost[3] •via auto •via transit •total of both modes	# jobs/$1000[2]
13. Financial Arrangements	—	—
14. Institutional Factors	—	—
15. Other	—	—

Note: [1]These criteria were presented in a sample evaluation matrix. More detail is available in the report.
[2]Quantitative measures
[3]Access criteria are included under cost and cost-effectiveness.
[4]Qualitative measures
[5]Include accident savings as well as travel time savings, vehicle operating savings, transit operating costs, O and M highway costs and capital costs.

TABLE 3
CRITERIA USED TO EVALUATE MAJOR TRANSIT INVESTMENTS—FEDERAL TRANSIT ADMINISTRATION

General Category		Criteria[1]	Measures
1.	Transportation System Performance	• Highway Congestion	Change in level of service, V/C ratio Change in VMT Change in hours of delay
		Parking	Change in number of CBD spaces required
		• Transit Service improvements	Population with reduced/increased travel time Passenger miles on reserved right-of-way Percentage of riders who transfer
		Ridership	Increase in number of daily riders Increase in person-miles of travel
2.	Mobility	Travel time savings	Hours of time saved (work/nonwork)
3.	Accessibility	Accessibility (general)	Population within __ feet of transit stop Jobs within __ feet of transit stop
		Accessibility (transit dependent)	Population within __ feet of transit stop Services within __ feet of transit stop
4.	System Development, Coordination and Integration	Feeder bus system Intermodal linkages	
5.	Land Use	Impact on development	Barriers to development Change in accessibility Resulting change in development patterns
		Community support	Supportive land use policies
		Consequences of development	Environmental, fiscal
		Joint development opportunities	Underdeveloped acreage within __ feet of transit stop
6.	Freight	Railroad	Impact on freight movements
		Trucking	Impact on deliveries

Note: [1]No specific set of criteria is required by the FTA. This list is typical of studies.

TABLE 3
CRITERIA USED TO EVALUATE MAJOR TRANSIT INVESTMENTS—FEDERAL TRANSIT ADMINISTRATION (*Continued*)

General Category	Criteria	Measures
7. Socioeconomic	Economic development	Construction jobs created Operations jobs created Multiplier effects
	Displacement and relocation	Number of residents affected Number of jobs affected
	Neighborhood impacts	Cumulative impacts
	Historic and cultural sites	Identification and review of sites
	Parklands	Identification and review of sites
8. Environmental	Air quality	Tons of emissions/day New violations of NAAQS Conformity with SIP
	Noise and vibration	Increase in noise levels Violations of noise standards
	Ecosystems	
	Water	
	Visual	
9. Energy	Energy conservation	BTUs for construction and operations Payback period
10. Safety and Security	Auto accidents	Number of accidents prevented
	Security	
11. Equity	Who pays? Who benefits?	Farebox recovery ratio Subsidy per trip
12. Costs	Capital costs	Dollars
	O&M costs	Dollars/year
12a. Efficiency	Cost-effectiveness	Added cost/new rider Added cost/hour of time savings
	Operating efficiency	Change in O&M cost per passenger
13. Financial Arrangements	Local share of capital costs	Percentage of capital cost
	Capital finance plan	Soundness
	O&M finance plan	Stability and reliability Farebox recovery ratio Subsidy per trip
14. Institutional Factors	Community support	Financial commitments Supporting land use and transportation policies
16. Other	Trade-offs summary	

TABLE 4
EVALUATION CRITERIA ADAPTED FROM ABRAMS AND DI RENZO (*10*)

General Category		Criteria[1]	Measures[2]
1.	Transportation System Performance	Capacity	
		• Volume to capacity	V/C ratio[3]
		• Level of service	A - F[3]
		Pedestrian and bicycle use	Counts[3]
		Transit use	
		• Number of passengers	Passengers[3]
		• Passenger miles of travel	PMT[3]
		Auto use	
		• Person miles of travel	PMT[3]
		• Traffic volumes	Volume[3]
		• Vehicle miles of travel	VMT[3]
		Reliability	
		• Freeway incident delay	Vehicle hours[3]
		• Transit schedule adherence	% on time[3]
		Comfort and convenience	
		• Frequency of transit service	Headways[3]
		• Transfers per transit passenger	Number[3]
		• Access/egress time, auto or transit	Time[3]
2.	Mobility and Accessibility	Travel time	
		• Point-to-point travel time	Time[3]
		• Person hours of travel	Time[3]
3.	System Development, Coordination and Integration	–	–
4.	Land Use	–	–
5.	Freight	–	–
6.	Socioeconomic	Displacement	Acres[3] Number of structures[3]
		Economic impacts	
		• Sales	Dollars[3]
		• Employment	Number[3]
7.	Environmental	Noise	Noise level[3]
		Air pollution	Tons of emissions[3]
8.	Energy	Energy consumption	BTUs[3]
9.	Safety	Safety	Accidents/million vehicle miles[3]
		Security	Crimes/million passengers[3]
10.	Equity	Equity	Population within 0.25 miles of bus route[3] Transportation disadvantaged ridership[3]
11.	Costs and Cost-effectiveness	Productivity	
		• Operating cost per passenger trip	$/trip[3]
		• Passenger revenue per vehicle hour	$/vehicle hour[3]
		• Revenue vehicle miles per revenue vehicle	Miles/vehicle[3]
		Use Costs	
		• Point-to-point transit fares	$[3]
		• Point-to-point out-of-pocket travel costs	$[3]
		O&M costs	$[3]
		Capital costs	$[3]
12.	Financial Arrangements	–	–
13.	Institutional Factors	–	–
14.	Other	–	–

Note: [1]In original references, the major criteria categories were termed objectives.
[2]Units were not always provided.
[3]Quantitative criteria

TABLE 5
METROPOLITAN TRANSPORTATION PLANNING FACTORS

1. Preservation of existing transportation facilities and, where practical, ways to meet transportation needs by using existing transportation facilities more efficiently.

2. The consistency of transportation planning with applicable Federal, State, and local energy conservation programs, goals, and objectives.

3. The need to relieve congestion and prevent congestion from occurring where it does not yet occur.

4. The likely effect of transportation policy decisions on land use and development and the consistency of transportation plans and programs with the provisions of all applicable with the provisions of all applicable short- and long-term land use and development plans.

5. The programming of expenditures on transportation enhancement activities as required in section 133.

6. The effects of all transportation projects to be undertaken in the metropolitan area, without regard to whether such projects are publicly funded.

7. International border crossings and access to ports, airports, intermodal transportation facilities, major freight distribution routes, national parks, recreation areas, monuments, historic sites, and military installations.

8. The need for connectivity of roads within the metropolitan area with roads outside the metropolitan area.

9. The transportation needs identified through use of the management systems required by section 303 of this title.

10. Preservation of rights-of-way for construction of future transportation projects, including identification of unused rights-of-way which may be needed for future transportation corridors and identification of those corridors for which action is most needed to prevent destruction or loss.

11. Methods to enhance the efficient movement of freight.

12. The use of life-cycle costs in the design and engineering of bridges, tunnels, or pavement.

13. The overall social, economic, energy, and environmental effects of transportation decisions.

14. Methods to expand and enhance transit services and to increase the use of such services.

15. Capital investments that would result in increased security in transit systems.

CHAPTER THREE

CURRENT PRACTICE IN MULTIMODAL EVALUATION

Several methods were used to assess the state of current practice in conducting multimodal transportation evaluation. The primary data collection tool was a survey mailed to all state DOT planning directors, many MPOs, and most Canadian provinces. The survey asked whether or not that agency engaged in multimodal planning or programming evaluation, and if so, who to contact for further information. It also requested documents, if they were available, describing the respondents' experiences. Names of other people involved in multimodal transportation evaluation were also requested, and many survey respondents provided numerous contacts. The people identified were subsequently contacted, and additional information was solicited. The survey materials are included as Appendix A.

Consultants and university personnel familiar with multimodal evaluation were contacted for further examples of multimodal transportation evaluation. Additional agencies such as FTA, FHWA, US DOT, and the GAO were contacted, and additional input was solicited.

SURVEY RESULTS

Survey forms were mailed in the fall of 1991 to all 50 states and the District of Columbia, 8 Canadian provinces, and 41 MPOs. These contacts and mailings produced 18 examples of multimodal planning evaluation or programming.

Table 6 summarizes the locations chosen for the synthesis to represent the practice of multimodal transportation evaluation. The areas were divided into four categories: intercity corridor evaluations, which cover corridors that connect urban areas within a state or Canadian province; regional evaluations that considered areawide transportation needs; urban corridor evaluations that considered a single corridor within an urban area; and examples of regional multimodal programming.

These four major classifications were further subdivided by the modes considered in the evaluation process. Table 6 also shows the variety of modes analyzed in the multimodal studies. Three studies (Chicago, New Jersey, Raleigh) only considered the trade-offs among general purpose highway lanes and high-occupancy vehicle (HOV) facilities. Several studies considered a wide range of modes, including four that reviewed ferry alternatives and one that involved demand management. None of the studies included nonmotorized modes, and, therefore, the criteria necessary to evaluate those options may not be available in existing methods.

INTERCITY CORRIDORS

Sacramento-San Francisco Intercity Corridor Study

Overview

In 1988 the US DOT, as part of the National Strategic Transportation Planning Study (NSTPS), studied five corridors around the country to help Congress ascertain important issues to be considered in the 1990s. The Sacramento-San Francisco Study involved one of these corridors and focused on long-range transportation issues within the approximately 100-mile I-80 corridor, which links the two regions (*12*). This corridor is served by various transportation services, including state highways, local arterials, Bay Area Rapid Transit (BART), the new Sacramento light-rail system, express bus service to the Bay area in Sacramento, ferry service from Vallejo to San Francisco, and intercity Amtrak passenger service. Several public bus systems also operate in the corridor. The planning issues important to this corridor included increasing congestion on I-80, particularly the western segment leading into San Francisco; a growing problem with traffic incidents; uncertain funding support for improvements; and, perhaps most importantly, the recognition that neither the Bay area nor the Sacramento area was in compliance with national ambient air quality standards for ozone and carbon monoxide. State clean-air legislation was even more stringent than federal standards, and, therefore, measures to increase ride-sharing opportunities, HOV facilities, and transit systems would have to be given important consideration.

Evaluation Methods

A summary of the project's evaluation matrix can be viewed in Table 7. The alternatives were compared to a year 2015 base case, which assumed completion of the existing 5-year plan. Under the category "The System," the table shows a mix of freeway, HOV, arterial, transit, and traffic operations improvements, with the alternatives becoming more capital intensive from alternative 1 to alternative 4. Following the descriptions of the system alternatives, the evaluation criteria relate to an environmental analysis, transportation analysis, and the necessary funding. Similar evaluation matrices were created for two other segments along the corridor between San Francisco and Sacramento.

The purpose of the study was not to fully evaluate specific transit and highway projects within the corridor but rather to evaluate concepts and strategies for future development of the corridor's transportation system. Because it was conceptual in nature, the study did not recommend specific projects within the alternatives but instead identified promising projects. Because no decision was required, no trade-off occurred among the alternatives across the selected evaluation criteria.

GO Train Service Expansion Program—Ontario, Canada

Overview

This study investigated the corridor between Whitby and Oshawa, Ontario, Canada (*13*). It examined the trade-offs among pro-

TABLE 6
OVERVIEW OF STUDIES REVIEWED FOR MULTIMODAL EVALUATION STUDY

	Date	Table No.	Alternatives Considered										
			Highway	HOV	TSM	Bus	Busway	LRT	HRT	CR	Ferry	TDM	Nonmotor.
Intercity Corridor													
San Francisco/Sacramento	1989	7	●	●	●	●		●		●			
Maryland Statewide √	1990	18	●	●		●		●		●			
Ontario	1990	8	●			●		●		●			
Regional													
Honolulu √	1984	19	●	●	●	●		●	●				
Toronto √	1990	20	●	●	●	●	●		●	●		●	
Seattle	1990	9	●	●	●	●		●			●		
Chicago	1991	10	●	●									
Urban Corridor													
Salt Lake City √	1987	21	●	●	●	●		●					
New Jersey, I-80	1992	—	●	●									
Raleigh, N.C., I-40	1988	—	●	●									
Tappan Zee, N.Y.	1987	—	●			●		●	●		●		
Marin/Sonoma, Calif.	1989	11	●	●		●	●	●		●	●		
Portland Bypass	1991	12	●	●				●					
Pittsburgh Parkway West	1989	13											
Regional Programming													
California Trans. Commission	1990	14	●	●	●	●	●	●	●	●			
San Francisco MTC √	1991	22	●	●	●	●	●	●	●	●	●		
Denver Interstate Transfer	1978	16	●	●		●							
Calgary Regional Screening	1990	17	●					●					

Notes: √ = Case Study Chapter 4

TABLE 7
SACRAMENTO-SAN FRANCISCO INTERCITY CORRIDOR STUDY (*12*)

	Alternative 1	Alternative 2	Alternative 3	Alternative 4
Objectives	Serves Primary Objectives • Improve air quality • Improve commute to Metro areas/ relieve gateway congestion • Manage travel demand • Manage highway and street operations	• Expand on Alternative 1 to achieve primary and secondary objectives.	• Same as Alternatives 1 & 2 plus adds new facilities	• Most capital intensive, adds remaining candidate projects
The System				
Freeways	—	—	• Construct Route 102 from I-80 east of Auburn to I-5 near airport • Widen I-5: airport to Woodland • Widen 113: I-80 to I-5	• Extend Route 102 across Yolo Bypass to I-80 (with no widening of Rt. 113) • Widen Rt. 51: E St. to I-80 • Construct beltway freeway from I-80 near Roseville to Route 113 near Dixon
HOV Lanes	• I-80: Add HOV lanes from Davis to Hwy. 50 and from I-5 to Roseville	• Extend HOV lanes from Roseville to Loomis	• I-5: Add HOV lanes from Route 102 to I-80	
Arterials	• Widen Roseville Road • Widen Auburn Blvd • Widen Elkhorn Blvd		• Widen Baseline Road • Widen Elverta Road • Extend Truxel Road across I-80 to downtown	• Extend Roseville Rd. from Marconi Ave. to Richards Blvd. extension
Transit	• Extend LRT to Antelope • Upgrade/extend express bus service from Davis, Woodland and Auburn to Sacramento	• Extend LRT to Roseville • Commuter rail service from Oakland and Auburn to Sacramento	• Extend LRT to North Natomas and West Sacramento	• Extend LRT to Davis and Woodland
TOS	• Ramp metering at school locations			
Environmental Analysis				
Air Quality	• Reduces VMT 6% and VHD 13% • Potential reductions in emissions	• Reduces VMT 7% and VHD 15% • Potential reductions in emissions	• Reduces VMT 5% and VHD 25% • Potential reduction in emissions	• Reduces VMT 8% and VHD 32% • Potential reductions in emissions
Other	Widening of arterials: • possible displacement of homes/business	—	Widen I-5 to Woodland: • potential impacts on sensitive areas Route 102: • potential for inducing growth LRT to North Natomas: • possible impacts on sensitive areas (bridge over American River and Parking)	Beltway freeway: • potential for major displacement of homes/businesses • possible impacts on sensitive areas • potential for inducing growth Route 51: • potential for major displacement of homes/businesses

TABLE 7
SACRAMENTO-SAN FRANCISCO INTERCITY CORRIDOR STUDY (*12*) (*Continued*)

Transportation Analysis				
Freeways	• Reduces VHD by 21% • I-80 LOS "F" Davis to Auburn • Auto travel time decreases 22 min. - Davis to Auburn	• Reduces VHD by 23% • I-80 LOS "F" Davis to Auburn • Auto travel time decreases 22 min. - Davis to Auburn	• Reduces VHD by 24% • I-80 LOS "F" Davis to Hwy. 50 and I-5 to Auburn • Auto travel time decreases 53 min. - Davis to Auburn	• Reduces VHD by 33% • I-80 LOS "E-F" I-5 to Auburn • Auto travel time decreases 46 min - Davis to Auburn
HOV	10,600 new carpoolers (4.7 % increase)	9.900 new carpoolers (4.4 % increase)	7,500 new carpoolers (3.3 % increase)	6,600 new carpoolers (2.9 % increase)
Arterials	• Reduces VHD by 13% • Congested lane-miles reduced 1%	• Reduces VHD by 16% • Congested lane-miles remain the same	• Reduces VHD by 26% • Congested lane-miles remain the same	• Reduces VHD by 32% • Congested lane-miles reduced 7 %
Transit	• 36,900 total daily commuters (13% decrease) • 3.9 % share	• 47,200 total daily commuters (12% increase) • 5.0 % share	• 58,100 total daily commuters (37% increase) • 6.2 % share	• 60,400 total daily commuters (43% increase) • 6.4 % share
Funding Requirements				
Capital				
Freeways/Arterials	$138 million	$228 million	$788million	$2,358million
Transit	100	180	410	700
TOS	20	20	20	20
TOTAL	$258 million	$428 million	$1,218 million	$3,078 million
Annual O & M				
Freeways/Arterials	$0.5 million	$0.6 million	$3.4 million	$4.1 million
Transit	3.6	4.8	5.7	6.8
TOTAL	$4.1 million	$5.4 million	$9.1 million	$10.9 million

[1]Evaluation compared to 2015 base case

viding commuter expansion through automobile-associated road improvements, bus transit improvements, light rail, and conventional commuter rail (GO Train).

Evaluation Methods

The evaluation process consisted of an examination of four strategic objectives and measures of those objectives' attainment, as shown in Table 8. A successful alternative had to be acceptable on all four objectives or be rejected as inconsistent with the Ontario Ministry of Transportation's intentions to provide improved service. These four broad objectives, which in this case formed the basis for the evaluation, included economic benefits, acceptable costs, acceptable social and economic impacts, and provision of a reasonable level of service. Environmental measures were dealt with throughout the entire document, which was submitted to meet the requirements of the Environmental Assessment Act of Ontario. This particular matrix is an example of a highly aggregated evaluation with a few measures and with qualitative evaluation of performance and could be viewed as a screening device.

REGIONAL STUDIES

Vision 2020 Growth Strategy and Transportation Plan for the Central Puget Sound Region—Seattle, Washington

Overview

This plan considered six different growth and transportation alternatives (*14*). The transportation system was developed to be complementary to its matched growth strategy. The combination provided a broad mix of transportation and land use options. These schemes were expected to accommodate an estimated 50 percent increase in population over the next 30 years.

Evaluation Methods

The evaluation for Vision 2020 took place in several stages. Table 9 shows the summary evaluation matrix with some of the key criteria used to evaluate the alternatives. The criteria were balanced among environment, transportation, land use, and cost. These criteria emphasized the balance between transportation and land use, which was a central theme for the study. This summary chart was supplemented with a wide variety of quantitative analyses, which provided the basis for Table 9.

The alternative selected represented a combination of major centers and multiple centers and was accepted without dissent by the MPO's governing board. This new plan has been the basis for development of growth strategies and major regional transit planning.

Chicago HOV Lane Feasibility Study

Overview

This study examined the feasibility of HOV lanes in several corridors in the Chicago region (*15*). Two radial corridors and one

TABLE 8
GO TRAIN EXPANSION PROGRAM ONTARIO, CANADA: COMPARISON OF ALTERNATIVE SCENARIOS/MODES WITH THE STRATEGIC OBJECTIVES

	Performance Alternatives				
STRATEGIC OBJECTIVE	(1) Base case	(2) Improved Roadways	(3) Improved Bus Service	(4) Light Rail Technology	(5) Conventional Rail Technology
1. Maximize potential economic benefits	♦	♦	♦	●	●
2. Acceptable implementation costs	●	*	●	♦	●
3. Acceptable level of social and economic impacts	●	*	●	●	●
4. Provide reasonable level of service	♦	♦	♦	●	●

● Acceptable performance
♦ Unacceptable performance
* Probably will occur anyway

Conclusion: The conventional rail technology scenario is the only one that meets all the strategic objectives and is therefore the only scenario carried forward.

circumferential corridor were selected for study. The key issues involved in the study were (1) the impact on transit ridership if HOV lanes were implemented, (2) the effect on general purpose lanes if a lane was removed for HOV purposes, and (3) how the demand for an HOV facility could be estimated if no HOV lanes existed previously.

Evaluation Methods

This study was part of a three-stage process for evaluating HOV lanes in the Chicago area. The report represented Stage 1, which was to determine the conceptual viability of HOV lanes in that particular corridor. If Stage 1 determined that the lanes were conceptually viable, the analysis would proceed to Stage 2, alternatives development, and then beyond that to Stage 3 for design recommendations. This Stage 1 report applied the screening process shown in Table 10. The basic criteria were congestion, potential travel time savings, demand, capacity improvement, and transit impact. Energy, air quality, and public support were considered separately. The congestion information was derived from data available from the Illinois Department of Transportation (IDOT), including hourly and daily volume counts, vehicle mix, average vehicle speeds, and vehicle density information. These data were supplemented where necessary with other traffic counts. Potential travel time savings were estimated from recently conducted origin-destination surveys for before information; a demand estimating model and calculations of speeds were used to derive future travel times. The travel demand for the corridor was developed with demand estimation techniques that provided quick response and low-cost calculations.

When capacity improvements were considered, the issue of whether to add a lane or convert an existing lane for HOV purposes was analyzed. Before and after comparisons were made to determine whether or not the improvement to the level of service for the HOVs would be offset by a lower level of service in the remaining general purpose lanes. The transit impact, as measured by transit ridership, was estimated through judgment and census data and was based on existing transportation services through the corridor. This screening process resulted in a recommendation that one corridor be considered for an additional HOV lane, and that no lane be converted from general purpose to HOV.

URBAN CORRIDOR

Interstate 80: HOV Lane Feasibility Study—New Jersey

Overview

Through northern New Jersey, Interstate 80 is extremely congested. This study was undertaken to assess the feasibility of adding HOV facilities in the corridor, which is about 11 miles long (*16*). One of the fundamental concerns was whether the additional capacity should be added as a general purpose traffic lane rather than an HOV lane.

TABLE 9
SEATTLE REGION EVALUATION: VISION 2020 GROWTH STRATEGY AND TRANSPORTATION PLAN, SELECTED CRITERIA (*14*)

Alternatives:	Air Quality	Open Space	Mobility Options Available	Transit/ Ridesharing	Environ. Sensitive	Energy Consump.	Delay & Congest.	TDM Potential (best suited)	Job Housing Balance	Transpor. Revenues Available at existing Distribution	Redistrib. Growth to Areas w/ Available Services	Level of Public Service	Overall Cost	Vehicle Travel	People Oriented Urban Design Likely
No Action	m	w	m	m	w	l	m	m	w	l	m	w	l	w	m
Existing Plans	w	w	w	w	w	w	w	w	w	w	w	w	w	w	w
Major Centers	l	l	l	l	w	l	w	l	w	m	l	l	w	l	l
Multiple Centers	l	l	l	l	l	l	w	w	l	m	l	l	w	l	l
Dispersed Growth	w	m	m	m	m	m	w	m	w	l	m	m	w	m	m
Preferred — 1	l	l	l	l	l	l	w	l	l	m	l	l	w	l	l

1 — Selected after initial evaluation efforts; combination of "Major Centers" and "Multiple Centers"

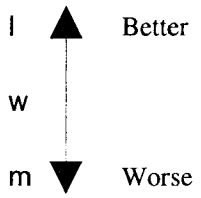

TABLE 10
CHICAGO HOV LANE FEASIBILITY STUDY—SCREENING GUIDELINES FOR HOV CANDIDATE CORRIDORS

Guidelines	Advantage	Neutral	Disadvantage
Criteria			
1. Congestion	●		
2. Potential Travel Time Savings		●	
3. Demand	●		
4. Capacity Improvement	●		
5. Transit Impact			●
Other Considerations			
6. Energy & Air Quality Impact		●	
7. Public Policy Support/ Non-Implementing Agency Support	●		

● = hypothetical evaluation

Evaluation Methods

No formal evaluation matrix was used in this study, but rather a narrative discussed each alternative. The study compared demand, measured by the number of people using HOV or general purpose lanes, with the impact on queue lengths resulting from congestion in the corridor. Travel time savings were also calculated for the alternatives. The air quality benefits that could be derived from the HOV lane were calculated with standard emission models. Various operational enforcement concerns were also addressed. This evaluation reflected a simple approach to a basic issue, that is, comparison of HOV versus general purpose lanes along a single, limited corridor. That approach is quite different from a comparison of many technologies, which has the potential for much higher cost and impacts.

Feasibility of HOV Treatments, Interstate 40—North Carolina

Overview

In the Raleigh-Durham region in North Carolina, the Research Triangle Park is a rapidly growing employment center supporting more than 30,000 jobs. This growth has led to congestion on the road system that serves the park. Interstate 40 is one such facility that has been under growing pressure. I-40 has been programmed for an increase from four to six lanes, and a study was undertaken to determine the feasibility of adding HOV facilities rather than general purpose lanes (*17*).

Evaluation Methods

The evaluation process concentrated heavily on existing and forecasted traffic volumes on the freeway facilities and relied on written summaries of the alternatives impacts. Researchers used a.m. and p.m. peak hour forecasts for the year 2008 as a basis for evaluation. Additional assessments considered the facilities' traffic operations characteristics, including weaving movements and their impact on travel safety. Cost was a factor: the HOV facility was assigned higher costs because of necessary signage and enforcement. The ease of enforcement and the ability to commit resources were also used as evaluation criteria. In addition, motorists' ability to understand the operation of the facility was considered. Warrants for HOV facilities that had been developed in New York were adapted for local conditions and used as part of the evaluation process here (*18*).

As a result of the evaluation of the proposed HOV lane and general purpose lane, along with a review of the warrants developed in New York City, an HOV lane was not recommended for this particular corridor. The forecasted number of vehicles that would qualify as HOVs was not high enough, and there was no existing or planned transit service in the corridor, which would have further weakened the cost-effectiveness of the facility. Instead, the researchers recommended that planners proceed with the possibility of constructing a physically separate HOV lane on the I-40 corridor sometime in the 1990s.

Tappan Zee Corridor Study—New York

Overview

The Tappan Zee Bridge, located north of New York City between Rockland and Westchester counties, is a toll facility on Interstate 87. In 1987 a study was conducted to determine how to deal with long-range traffic growth in this corridor (*19*). The alternatives were to build a new bridge; implement a combined transit/transportation systems management strategy; and consider other modes, including ferry service, fixed guideway alternatives, and commuter rail.

Evaluation Methods

Each alternative was evaluated on the basis of (1) its impact on travel in the study area and, more specifically, across the Tappan

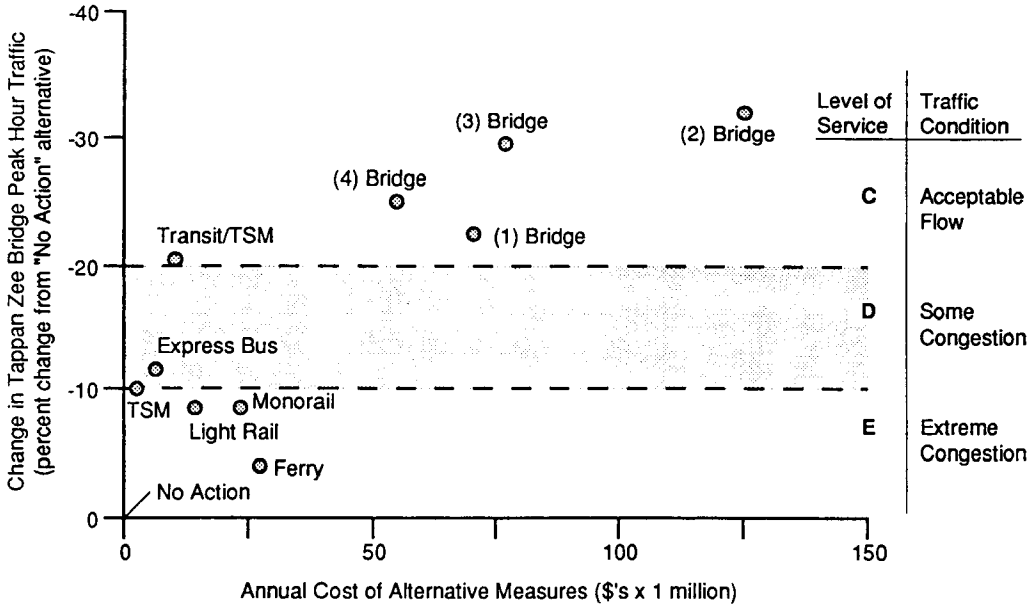

Figure 1 Change in Tappan Zee Bridge traffic resulting from alternative measures versus cost of alternatives (*19*).

Zee Bridge; (2) the estimated equivalent annual cost to implement the alternative; and (3) the cost-effectiveness ratio of each alternative as it related to the alternative's impact on peak-hour traffic on the bridge. A written summary evaluation described how well each alternative met the evaluation criteria. No evaluation rating was presented. Figure 1 shows the cost-effectiveness trade-off reviewed for the alternatives. This compared the impact of the alternative on peak-hour bridge traffic to the annual costs of the alternative. In addition to the three formal criteria mentioned previously, public reaction played an important and influential role in the evaluation process. Comments from numerous public meetings were synthesized and used as important factors in the development of recommendations for the corridor. The evaluation focused on improvements in vehicular congestion within the study corridor and on the bridge specifically.

101 Corridor Plan—Marin/Sonoma Counties, California

Overview

The Association of Bay Area Governments (ABAG) has projected a 50 percent increase in commuting in the north San Francisco Bay area over the next 20 years. Physical characteristics of the 101 corridor north of the Golden Gate Bridge severely constrain expansion of transportation service, so a multimodal study was undertaken to delineate possible options (*20*). The options included no-action alternatives, expansion of ferry service, HOV lanes, busway alternatives, commuter rail, light rail, and highway expansion.

Evaluation Methods

The evaluation process for this corridor took place in stages. The most detailed component can be seen in Table 11, which shows the principal evaluation criteria used to screen 11 alternatives. As the table shows, the operation of Highway 101, with its low level of service and severe traffic congestion, was an important consideration. Transit ridership across the alternatives was also considered. Total capital and annualized capital costs, along with transit operating costs, were included. Total annual costs for both highway and transit were calculated. A transit cost-effectiveness measure of cost per passenger mile rather than cost per passenger, as is traditionally done in alternatives analysis, was calculated. Then the total funding requirement for a 20-year period, along with the shortfall, was figured for evaluation. Air quality issues such as major pollutant emissions were considered in other evaluation matrices created during the project. Because of the similar performance of transit service and two of the preferred alternatives, public opinion played an important role in the selection of the transit component for the project. A survey of 500 Marin County and 500 Sonoma County voters indicated that the most important transit element was the passenger rail service.

Western Bypass Study—Portland, Oregon

Overview

The Western Bypass Study in Portland, Oregon, analyzed a range of highway and transit alternatives to provide service to the fast growing and congested Portland metropolitan area (*21*). The range of alternatives evaluated included no-build arterial expansion, light rail expansion, transit HOV arterial development, and two highway bypass options. An innovative alternative was added during the process that emphasized land use changes, demand management, transit, and nonmotorized transportation. This alter-

TABLE 11
HIGHWAY 101 CORRIDOR PLAN—MARIN/SONOMA COUNTIES, CALIFORNIA: TESTING RESULTS FOR PHASE II ALTERNATIVES (*20*)

PERFORMANCE INDICATORS	ELEVEN PHASE II TRANSPORTATION ALTERNATIVES FOR 2005											
	1985	1 Existing System	2 Baseline	3 Ferries	4 HOV Lanes	5 Busway I	6 Busway II	7 Commuter Rail I	8 Light Rail I	9 Light Rail II	10 Highways	11 Phase I Preferred
OPERATION OF HIGHWAY 101												
Level of Service												
Todd Road South of Santa Rosa	C	F	F	F	F	F	F	F	F	F	C	E
Sonoma/Marin County Line	D	F2	F2	F2	F1	F1	F2	F2	F2	F2	E	F1
Puerto Suelo Hill in San Rafael	F2	F6	F4	F4	F3	F4	F2	F2	F2	F2	F4	F3
Golden Gate Bridge	D/E	E	D/E	D/E	F	F	F	E	D/E	D/E	D/E	F
Miles of Severe Congestion												
Sonoma County	0	21	19	20	18	18	18	20	20	19	0	17
Marin County	7	15	13	14	11	14	13	14	14	14	12	12
TRANSIT RIDERSHIP (Includes Transfers)												
Daily												
Ferry	4,800	4,800	9,200	23,900	7,800	10,500	24,400	18,200	16,400	27,900	7,800	24,000
Bus	37,200	52,400	71,100	52,300	75,900	65,600	75,300	46,100	54,000	44,300	67,400	69,500
Rail	—	—	—	—	—	—	—	11,600	13,800	3,900	—	—
Total Daily Passengers	42,000	57,200	80,300	76,200	83,700	76,100	99,700	75,900	84,200	107,100	75,200	93,500
Total Peak Hour Passengers	8,300	11,500	15,300	13,500	16,000	14,400	18,500	15,700	16,200	18,500	14,300	17,900
CAPITAL COSTS (Millions)												
Transit	—	$174	$202	$301	$299	$207	$439	$368	$361	$537	$180	$340
Highway	—	0	59	59	288	200	59	59	59	59	353	353
Total	—	174	261	360	487	407	498	427	420	596	533	693
ANNUALIZED CAPITAL COST (Millions)												
Transit	—	26	30	39	29	30	57	44	45	62	27	45
Highways	—	0	7	7	34	24	7	7	7	7	42	42
Total	—	27	39	46	65	54	64	51	52	69	71	87
TRANSIT OPERATING COSTS (Millions)												
Total Annual Costs	$43	$72	$89	$91	$90	$80	$101	$66	$85	$80	$84	$96
Less Operating Revenue	17	28	37	40	39	35	46	30	38	45	35	42
Net Operating Costs	26	44	52	51	51	45	55	36	47	35	49	54
TOTAL ANNUAL COSTS (Millions)												
Transit	—	$70	$82	$90	$80	$74	$112	$79	$93	$98	$76	$99
Highway	—	—	7	7	34	24	7	7	7	7	42	42
Total	—	70	89	97	114	98	119	86	100	105	118	141
TRANSIT COST EFFECTIVENESS (Cents/Passenger Mile)												
Annualized Capital Costs / Passenger Mile	—	13¢	11¢	14¢	10¢	11¢	16¢	20¢	16¢	17¢	10¢	14¢
Net Operating Costs Per Passenger Mile	—	21	18	18	17	17	16	16	17	10	19	16
Total Costs Per Passenger Mile	—	34	29	32	27	28	32	36	33	27	29	30
TOTAL FUNDS REQUIRED OVER 20 YEARS (Billions)												
System Expansion	—	$0.9	$1.3	$1.4	$1.7	$1.4	$1.8	$1.2	$1.4	$1.5	$1.7	$2.1
Maintain and Operate Existing System	—	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0	4.0
Funds available From Existing Programs	—	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1	3.1
20 Year Shortfall	—	1.8	2.2	2.3	2.6	2.3	2.7	2.1	2.3	2.4	2.6	3.0

* The carrying capacity of the exisitng 1985 transit system was increased by 85% to meet the projected transit demand for the exisitng system in the year 2005. If this additional seat capacity is not provided, then transit use and costs would be lower and highway congestion would be greater

native is not shown in this document but is receiving the same detailed evaluation.

Evaluation Methods

The evaluation was designed to be applied at three stages in the overall study: first, during the screening of conceptual, system-level strategies; next during the development and feasibility analysis of corridor alternatives; and finally, to select a preferred alternative. Table 12 outlines the evaluation matrix and shows whether the criteria were qualitative or quantitative. As the table shows, reduced traffic congestion on specific facilities, as well as areawide measures, was considered. On the basis of either quantitative or qualitative measures, or a combination of both, an overall qualitative summary was produced for each major criterion.

Accessibility, a quantitative measure of travel times to employment, households, and retail centers, is the next measure in the table. Through-traffic diversion was addressed both quantitatively and qualitatively with a summary assessment. Safety was addressed only qualitatively. Reduction of reliance on single-occupant vehicles was a quantitative assessment represented by total numbers of people, available modes, and mode share. Providing flexibility for future needs, a criterion with long-term impacts on the natural environment, was measured qualitatively (with reserved capacity) with the usual environmental measures. Impacts on the natural environment were expressed qualitatively. A criterion that measured the support of efficient land development patterns was represented as a qualitative assessment. The measure of pressure on the urban growth boundary was also qualitative. The urban growth boundary in Oregon is a border established to shape and contain growth within the Portland area; urban growth is not supposed to spill beyond the boundary unless the boundary line is changed. Disruption to neighborhood business communities and the economic health of the study area were both qualitative assessments.

Parkway West Multimodal Corridor Study—Pittsburgh

Overview

The corridor to the west of Pittsburgh includes suburban centers with populations that are growing at a moderate pace, employment locations that are growing significantly faster, and the Greater Pittsburgh International Airport. With the continuing dominance of the employment center in downtown Pittsburgh, an aggressive long-range plan was needed (*22*).

Evaluation Methods

The evaluation was conducted in three stages, as shown in Table 13. The recommended program at the bottom of Table 13 represents a combination of the better elements of programs A through E. The criteria (or in this case the measures of effectiveness) used for this study included highway speed; level of service, as measured by deficient lane miles; vehicle miles traveled (VMT) and vehicle hours traveled (VHT); average daily volumes over critical segments; average transit speeds and ridership; and finally, capital cost measures. Operating costs were not considered in the evaluation matrix.

In general, the preliminary recommended program combined highway elements from program C with transit elements from program B. For both technical and political reasons, many evaluations end with a preferred alternative that is different from any of the alternatives that were evaluated.

REGIONAL PROGRAMMING EVALUATIONS

Flexible Congestion Relief Program—California Transportation Commission

Overview

The flexible congestion relief program in California was developed to provide both rural and urban regions throughout the state with the opportunity to compete for $3 billion over a 10-year period for relieving congestion through multimodal alternatives (*23*). The intent was to provide integrated and coordinated solutions to congestion problems statewide. Criteria were developed so that projects from different regions of the state could compete for the congestion relief funds. Criteria were not developed to provide regional priorities or an overall statewide priority list, both of which have their own procedures.

Evaluation Methods

The evaluation is a two-part process. First, a screening takes place to establish a project's ability to compete on a statewide basis and to reduce the burden of having to evaluate unlikely candidates for funding. The screening criteria, all of which have to be met, are as follows:

1) Current congestion—In this case, congestion is defined as an unacceptable level of service based on traffic conditions that exist when a project is nominated.
2) Regional approval—The project must be consistent with the most recent update of the regional transportation plan.
3) Ability to maintain and operate—The operating agency must certify its willingness and ability to maintain and operate the facility once the improvement has been completed.
4) Air quality—For nonattainment areas, the project must be consistent with the most recent local air quality plan.
5) Project study report—A project study report must be completed for the project.
6) Pavement management certification—The responsible local agency must certify that the project complies with a mandated pavement management program.

Once a project has met the initial screening criteria, it may proceed to the next level of evaluation. This level of evaluation may employ a set of more quantitative criteria and qualitative criteria, as shown in Tables 14 and 15. The quantitative criteria are listed in general order of importance. As can be seen in Tables 14 and 15, traditional traffic engineering measures of congestion are used in the most important evaluation criteria. Load factors for rail transit provide the equivalent transit congestion measure. The cost-effectiveness of the project is determined by calculating

TABLE 12
WESTERN BYPASS STUDY—PORTLAND (*21*)

Evaluation Criteria	No-Build	Common Improve-ments	Arterial Expansion	Transit Intensive (LRT)	Transit (HOV) Arterial Expansion	Bypass Option A	Bypass Option B
Reduced Traffic Congestion							
Improvement in Level-of-Service over No-Build							
Highway 217	+/-	+/-	++	+/-	+	+	+
PM Peak-Hour Vehicle Hours of Delay (VHD)							
Total All Classes	3,646	2,574	1,959	2,601	2,026	2,101	2,205
Change in VHD as Compared to No-Build							
Total All Classes	NA	-29.4%	-46.3%	-28.7%	-44.4%	-42.4%	-39.5%
PM Peak-Hour Vehicle Hours of Travel (VHT)							
Total All Classes	24,699	23,444	23,041	23,481	23,078	23,193	23,176
Change in VHT as Compared to No-Build							
Total All Classes	N/A	-5.1%	-6.7%	-4.9%	-6.6%	-6.1%	-6.2%
Relative Congestion Reduction Rating	+/-	+/-	++	+/-	++	+	+
Accessibility							
Relative Accessibility Rating	+/-	+	++	+	++	++	+
Through Traffic Diversion							
North-South Arterial Capacity (Vehicles per Hour)	+/-	+/-	+	+/-	+	++	++
PM Peak-Hour Vehicle Miles of Travel (VMT)							
All Roadway Facilities	683,200	687,700	707,000	688,000	704,600	719,700	708,700
Change in VMT as Compared to No-Build							
Change in VMT on All Roadway Facilities	N/A	4,500	23,800	4,800	21,400	36,500	25,500
Relative Congestion Reduction Rating (from above)	+/-	+/-	++	+/-	++	+	+
Relative Through-Traffic Diversion Reduction Rating	+/-	+/-	+	+/-	+	++	++

the cost for providing additional vehicle or passenger trips per hour. In this case, project costs are the sum of total cost for right-of-way and construction, but not operations. This appears to give some advantage to transit projects. Another indication of cost-effectiveness is the dollar value of reducing travel time during peak hours in comparison to project costs. This calculation of marginal costs for peak-hour improvements is found by dividing the total project cost with right-of-way and construction by additional peak-hour person trips served. Local financial participation is also considered. Finally, the estimated level of service on the highway or rail transit after the project has been implemented is estimated for some future year not to exceed 10 years from the current period.

The transportation commission may also use the qualitative cri-

TABLE 12
WESTERN BYPASS STUDY—PORTLAND (*21*) (*Continued*)

Evaluation Criteria	No-Build	Common Improvements	Arterial Expansion	Transit Intensive (LRT)	Transit (HOV) Arterial Expansion	Bypass Option A	Bypass Option B
Safety							
Relative Safety Rating	+/-	+/-	+	+/-	+	++	++
Reduced Reliance on Single-Occupancy Vehicle (SOV)							
Total Study Area Average Weekday Person Trips (x 1,000)	1,577	1,577	1,579	1,578	1,579	1,579	1,579
Total Work Person Trips (x 1,000)	315	316	316	316	316	316	316
Growth in Work Person Trips by Mode, Relative to No-Build							
Percent Change in Transit Trips	N/A	9.0%	10.0%	9.0%	10.0%	11.0%	10.0%
Work Trips by Modal Share							
Percent Work Trips by Transit	3.2%	3.5%	3.5%	3.5%	3.5%	3.5%	3.5%
Relative Reduction in SOV Dependency (Work Trips)	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Total Non-Work Person Trips (x 1,000)	1,262	1,261	1,263	1,263	1,263	1,263	1,263
Growth in Non-Work Trips by Mode Relative to No-Build							
Non-Work Trips by Modal Share							
Relative Reductions in Auto Dependency (Non-Work Trips)	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Total Study Area Vehicle Trips (x 1,000)	1,183	1,209	1,211	1,209	1,210	1,211	1,210
Percent of Study Area Population Within 1/4-Mile of a Transit Route	64%	65%	65%	65%	65%	65%	65%
Potential to Spread Peak-Hour Traffic	+/-	+/-	-	+/-	-	-	-
Relative Reduction in SOV Dependency (All Trips)	+/-	+/-	+/-	+/-	+/-	+/-	+/-

teria shown in Tables 14 and 15 to establish relative priorities for the congestion relief program. These criteria are supplemental and necessarily subjective, and are not listed in any order of importance. These qualitative measures address how well the project ties into the existing transportation system through intermodal connections, and how it meshes with the overall transportation system. The project's ability to serve special trip generators, such as airports or seaports, is also a factor. The overall measure of the acceptability of the project's community impacts, environmental impacts, and energy efficiency is a consideration. Finally, the degree to which the projects address freight traffic and congestion related to freight traffic is considered.

TABLE 12
WESTERN BYPASS STUDY—PORTLAND (*21*) (*Continued*)

Evaluation Criteria		No-Build	Common Improvements	Arterial Expansion	Transit Intensive (LRT)	Transit (HOV) Arterial Expansion	Bypass Option A	Bypass Option B
Provide Flexibility for Future Needs								
Ability to Increase Capacity of Facility (or Add Service) Over Time		+/-	+/-	+/-	+	+	++	++
Ability to Adapt to Changing Travel Conditions or Modes		+/-	+/-	+/-	+	+	+	+
Long-Term and Short-Term (Construction) Impacts on Natural Environment, Including:								
Hydrology/ Water Quality Impacts	Long-term	+/-	-	-	-	-	-	-
	Short-term	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Ecosystems/ Wetlands Impacts	Long-term	+/-	-	-	-	-	- -	- -
	Short-term	+/-	-	-	-	-	- -	- -
Air Quality Impacts	Long-term	+/-	+	+	+	+	+	+
	Short-term	+/-	-	-	-	-	-	-
Agricultural and Forest Land Impacts	Long-term	+/-	+/-	+/-	+/-	+/-	-	-
	Short-term	+/-	+/-	+/-	+/-	+/-	-	-
Energy Impacts	Long-term	+/-	+/-	+/-	+/-	+/-	+/-	+/-
	Short-term	+/-	-	-	-	-	-	-
Visual Resource Impacts	Long-term	+/-	+/-	-	-	-	-	-
	Short-term	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Geological Resource Impacts	Long-term	+/-	+/-	-	+/-	-	-	-
	Short-term	+/-	+/-	-	+/-	-	-	-

Denver Regional Council of Governments' Highway Transit Program and Process

Overview

The Denver area began prioritizing highway and transit projects together in 1978 because of the interstate substitution program, which allowed funding of both highway and transit projects from the same funding source (*8*).

Evaluation Methods

The Denver criteria and scoring methods used at that time are shown in Table 16. The criteria listed are heavily weighted toward

TABLE 12
WESTERN BYPASS STUDY—PORTLAND (*21*) (*Continued*)

Evaluation Criteria		No-Build	Common Improvements	Arterial Expansion	Transit Intensive (LRT)	Transit (HOV) Arterial Expansion	Bypass Option A	Bypass Option B
Long-Term and Short-Term (Construction) Impacts on Built Environment, Including:								
Land Use Impacts (Acquisition of Land)	Long-term	+/-	-	-	-	-	- -	- -
	Short-term	+/-	-	-	-	-	-	-
Impacts on Public Facilities/Services	Long-term	+/-	+	+	+	+	+	+
	Short-term	+/-	+/-	+/-	+/-	+/-	+/-	+/-
Supports Efficient Urban Development Patterns								
Provides for Efficient Delivery of Urban Services								
Consistency with Existing Local Plans as Adopted and Acknowledged		+/-	+/-	-	-	-	-	-
Consistency with State and Regional Plans		+/-	+/-	-	-	-	-	-
Pressure on Urban Growth Boundary								
Location of Improvement(s) Relative to Fringe of UGB		+/-	+/-	+	+	+	- -	-
Ability to Mitigate Potential Negative Impacts		+/-	+/-	+/-	+/-	+/-	+/-	+/-
Proximity of Improvement(s) to Vacant Urban Land		+/-	+/-	+	+	+	-	-
Proximity of Improvement(s) to Vacant Urbanized Land		+/-	+/-	+	+	+	-	-
Costs								
Relative Construction Costs		$	$$	$$$	$$$$	$$$	$$$	$$$
Relative Annual Public Operations and Maintenance Costs		$	$$	$$$	$$$$	$$$	$$$	$$$

projects that conform to regional and local plans, have a significant transit component, and provide for general capacity improvements. A project can score a maximum of 12 points in this method. After initial ranking, additional criteria, such as project cost and geographical representation, helped decide which projects ultimately received funding. With this process, 24 percent of interstate substitution funds were allocated to fund mass transit or transit related projects. This process was only used for interstate substitution projects. Different planning procedures are used for other highway and mass transportation projects.

TABLE 12
WESTERN BYPASS STUDY—PORTLAND (*21*) (*Continued*)

Evaluation Criteria	No-Build	Common Improvements	Arterial Expansion	Transit Intensive (LRT)	Transit (HOV) Arterial Expansion	Bypass Option A	Bypass Option B
Neighborhood/Business Community Disruption							
Relative Displacement of Residences and Businesses	+/-	-	- - -	- -	- - -	- -	-
Relative Rural Displacement	+/-	+/-	+/-	+/-	+/-	- -	-
Economic Health of Study Area							
Supports Regional/Local Economy							
Relative Study Area Employment Accessibility	+/-	+	+ +	+	+ +	+ +	+ +
Relative Study Area Residence Accessibility	+/-	+	+ +	+	+	+	+
Relative Study Area Retail Accessibility	+/-	+/-	+	+/-	+	+	+/-

Transportation Improvement Priority Study—Calgary, Canada

Overview

The Calgary metropolitan area has been conducting transportation improvement priority studies since 1958. The process was updated in 1968 and, in 1970, began to include transit projects as well as highway projects. This process has guided the development of transportation in the Calgary region and has been adjusted as necessary to account for new issues and new priorities (*24*).

Evaluation Methods

The evaluation criteria used in the Calgary process are shown in Table 17. Some of these evaluation factors lend themselves to quantitative measurement, whereas others are necessarily qualitative. The method used to develop priorities is to first rank the achievement of various project alternatives in terms of these transportation criteria. This rank is then weighted by the relative importance of the criterion to produce an overall, weighted score to determine the priority of the project, as shown in Table 17. The lowest scores indicate the best projects. Recommendations for funding road and transit projects are shown in the first column.

TABLE 13
PARKWAY WEST STUDY—PITTSBURGH (22)

ALTERNATIVE PROGRAMS	MEASURES OF EFFECTIVENESS															CAPITAL COST (Millions) ($)	CUMULATIVE CAPITAL COST (Millions) ($)
	HIGHWAY SPEED		LEVEL OF SERVICE				AVERAGE DAILY VOLUMES					TRANSIT SPEED		RIDERSHIP			
	Avg. Speed	Rating	Deficient Lane Miles	Rating	VMT	VHT	West End	Ft. Pitt Bridge	Liberty Bridge	Ft. Pitt Tunnel	Liberty Tunnel	Avg Speed	Rating	System Wide	Facility		
NO ACTION	47.63	—	337.4	—	6632926	139268	43600	115500	48800	95400	55700	17.7	—	382200	—	$ 0	$ 0
STAGE 1 (all programs)	48.02	.6	217.1	2.3	6633827	138137	44600	125100	50000	99700	48400	17.7	—	382200	—	$78.2	$78.2
STAGE 2																	
Program A	49.52	3.3	152.15	3.6	6709334	135485	39800	110100	76200	87200	63900	18.2	1.6	403400	28800	$370.0	$448.2
Program B	49.11	2.6	154.14	3.5	6730098	137030	43400	130100	50500	120800	46600	18.6	2.8	401000	31900	$288.1	$366.3
Program C	49.01	2.4	153.73	3.6	6658902	135859	33300	117700	49200	84100	48500	18.7	3.1	404100	31500	$306.1	$384.3
Program D	49.48	3.2	145.57	3.7	6707224	135564	39600	113700	76600	85800	63600	18.5	2.5	400600	31800	$312.0	$390.2
Program E	48.80	2.1	169.30	3.3	6707833	137453	39500	110000	78000	89200	64600	18.2	1.6	402900	28500	$220.0	$298.2
STAGE 3																	
Program A	50.48	5.0	100.50	4.6	6879973	136300	39200	101400	72900	73700	64400	18.8	3.4	408000	36700	$474.0	$922.2
Program B	50.36	4.8	101.50	4.6	6871813	136434	37200	105600	46400	731000	43400	19.0	4.1	405700	39200	$541.0	$907.3
Program C	50.27	4.6	78.86	5.0	6843694	136133	28500	105500	44500	74900	42700	18.7	3.1	403300	31300	$1281.0	$1665.3
Program D	50.45	4.9	110.40	4.4	6895721	136675	38600	106100	72900	75600	66100	19.3	5.0	406900	43600	$1219.0	$1609.20
Program E	49.82	3.8	137.82	3.9	6867758	137856	38100	101400	94700	77500	63400	19.0	4.1	403800	44600	$1096.0	$1394.20
RECOMMENDED PROGRAM (all stages)	49.41	3.1	131.03	4.0	6612410	133827	29100	111100	48400	83600	49100	19.1	4.4	407868	48748	—	$472.3

NOTE: Ratings range from 0 to 5 with 0 being the lowest and 5 being the highest.

TABLE 14
CALIFORNIA TRANSPORTATION COMMISSION PROJECT EVALUATION SHEET: HIGHWAY, STREET, AND ROAD PROJECTS (*23*)

Project Evaluation Sheet: Highway, Street and Road Projects

- **County**: Orange **Route**: I-5 **PM**: 36.9 to 38.6
- **Project Location**: From 0.1 north of Haster Street to Broadway

  Existing Facility: Six (6) mixed flow lanes in both directions (Segment B)
- **Proposed Project**: Widening of freeway to eight mixed flow lanes plus two HOV lanes with buffers. Auxiliary lanes will be provided between on and off ramps.
- **Capital Cost**:

	1991 $	**Escalated $**: FY 1997-98
Project Development:	5,464,000	
Right of Way:	77,379,000	117,043,000*
Construction:	68,306,000	88,952,000
Total	151,149,000	205,995,000

CTC SCREENING CRITERIA		**Yes**	**No**
A.	Existing congestion	X	___
B.	Consistent with Regional Transportation Plan	X	___
	Consistent with Congestion Management Program	X	___
C.	In a plan with air quality conformity finding	X	___
D.	Project Study Report complete	X	___
E.	Willing and able to maintain and operate	X	___
F.	Pavement Management certification	X	___

CTC QUANTITATIVE CRITERIA

1. Existing Facility & Conditions:		Current	10 Years (Yr 2000)
• Capacity (Veh/Hr)		11,400	11,400
• Average Daily Traffic		171,000	242,000
• Peak Hour: Volume	(Veh/Hr)	14,800	16,600
	(Pers/Hr)	17,300	19,900
	1 direction or both	Both	Both
	Level of Service and Speed	F-1; 25 mph	F-3; 25 mph
	Veh Occupancy (Est'd)	1.17	1.20
	Demand Capacity	1.30	1.50
• Duration of LOS E or F (Hr/Wk)		29	44
• Estimated Person Delay (Hr/Yr)		376,650	617,360
• % Trucks		7 %	___

2. Project Improvements	10 Years (Yr 2000)
• Capacity after project (Veh/Hr)	18,000
• Peak Hour: Volume (Pers/Hr)	20,400
Level of Service and Speed	D; 45 mph
Demand/Capacity	0.92
• Duration of LOS E or F (Hr/Wk)	0
• Estimated Person Delay (Hr/Yr)	0

3. Cost Effectiveness:	10 Years (Yr 2000)
• Capital cost/added capacity	$10,349**
• Capital cost/delay saved	III**

4. Local Financial Participation: State $ 37 % of Total Capital Cost

TABLE 15
CALIFORNIA TRANSPORTATION COMMISSION PROJECT EVALUATION SHEET: TRANSIT PROJECTS (*23*)

Project Evaluation Sheet: Transit Projects

- **County:** Alameda **Route:** Fremont
- **Project Location: (Specify Boundaries)** See detailed map _____

  Existing Conditions: Facility: None_____
- **Proposed Project:** 5.4 mile BART extension from current Fremont station to Irvingston and Warm Springs districts. Project includes vehicle purchase and systemwide support.

CTC SCREENING CRITERIA		Yes	No
A.	Existing congestion	X	___
B.	Consistent with Regional Transportation Plan	X	___
	Consistent with Congestion Management Program	X	___
	Consistent with LOS Transit Standards	X	___
C.	In a plan with Air Quality conformity	X	___
D.	Project Study Report complete	N/A	___
E.	Willing and able to maintain and operate	X	___

CTC QUANTITATIVE CRITERIA

		Current	Projected in 2000
1.	Existing Facility & Conditions:		
	• Capacity (Pers/Hr)	N/A	N/A
	• Daily Ridership	N/A	17,500
	(2010) WSX		
	• Peak Hour: Headway	N/A	2:15
	(min:sec) Volume (Pers/Hr)	N/A	N/A1
	direction or both N/A 1		Load Factor
	N/A 1.15 peak Volume/Capacity	N/A	1.00
	off-peak		
	• Duration of Peak Loads (Hr/Wk)	N/A	30/hr/wk
	• Estimated Rider Delay (Hr/Yr)	N/A	94% on-time
2.	Project Improvements		
	• Capacity after project (Pers/Hr)		N/A
	• Peak Hour: Load Factor		1.15 peak
	Volume/Capacity 1.00 off-peak		
	• Duration of Peak Loads (Hr/Wk)		30/hr/wk
	• Estimated Rider Delay (Hr/Yr)		94% on-time
3.	Cost Effectiveness:		
	• Capital cost/added capacity		N/A
	• Capital cost/delay saved		N/A
4.	Local Financial Participation: State $ = 20 % of Total Capital Cost		

TABLE 16
DENVER REGIONAL COUNCIL OF GOVERNMENTS' CRITERIA AND SCORING MEASURES

General requirements:

Projects must
- be of regional significance,
- be major construction projects,
- be supported by the local governing body, and
- demonstrate local financial support

Projects should
- further regional air quality improvement goals by encouraging higher vehicle occupancy and decreasing vehicle miles traveled, and
- consider the mobility of the elderly, the handicapped, and minorities.

Description	Scores for Specific Measures		
	+1	0	-1
Project is/is not on the regional long-term transportation plan;			
Project is/is not on a local transportation plan that supports the regional long-term transportation plan;			
Project is/is not recommended in a related transportation study;			
Project is/is not coordinated with other communities, or is contained within a city boundary;			
Project includes/does not include transit design features;			
Project includes/does not include a designated deficient bridge;			
A score of +1/-1 for the projects with the highest/lowest number of daily commuter trips;			
A score of +1/-1 for the projects with the highest/lowest system capacity;			
A score of +1/-1 for the projects with the highest/lowest improved roadway safety;			
Project does/does not provide for HOV capacity in addition to other transit capacity;			
Project includes/does not include special provisions for elderly, handicapped, and minority individuals;			
Roadway project provides for transit service or relieves severe congestion.			

TABLE 17
CALGARY REGIONAL SCREENING METHOD (*24*)

# CANDIDATE PROJECTS	1985 TIP	safety	mobility	enviro.	land use	best use	devel	system	recommended projects
1. Northwest LRT Extension to 53 Street W.	8	4	6	13	5	5	6	20	#1 LRT
2. South LRT Extension to Midnapore	19	10	17	17	11	13	17	23	#2 LRT
3. Macleod Trail/Canyon Meadows Drive	17	14	15	20	15	17	11	10	
4. Macleod Trail/Anderson Road	11	19	7	18	6	7	8	14	#3 Road
5. Macleod Trail/Southland Drive	8	2	8	8	8	17	4	3	
6. Macleod Trail/Heritage Drive	19	6	15	15	15	21	11	17	
7. 14 Street W., 90 Avenue S. to Southland Drive	11	19	13	14	18	15	20	8	
8. Glenmore Trail/Elbow Drive & 5 Street W.	2	1	2	4	6	1	2	2	#2 Road
9. Crowchild Trail/50 Avenue S.	11	12	13	18	14	7	8	8	#4 Road
10. Stoney Tr., Trans Canada Hwy. to Nose Hill Dr.	17	21	8	15	8	17	11	21	
11. Trans Canada Highway/Shaganappi Trail	24	24	24	25	24	25	28	21	
12. 16 Ave. N. (TCH) 4 St. W. to 14 St. W.	11	5	19	7	18	7	8	14	
13. 16 Ave. N. (TCH), 6 st. E. to 1 St. E.	15	14	20	8	20	10	11	17	
14. Crowchild Tr. Shaganappi Tr.	21	22	17	21	11	22	17	12	
15. Sarcee Tr., John Laurie Blvd to Country Hills Blvd.	4	10	4	3	3	5	6	7	#5 Road
16. Shaganappi Tr. & Country Hills Blvd., Edgemont Blvd. to 14 St. W.	6	14	5	8	4	10	4	10	#4 Road
17. Country Hills Blvd & Beddington Tr. 14 St. W. to Beddington Blvd.	3	6	3	2	2	3	3	3	#1 Road
18. Beddington Tr. Deerfoot Tr. to Beddington Blvd.	1	2	1	1	1	2	1	1	#1 Road
19. McKnight Boulevard 12 Street East	5	6	8	8	8	3	11	3	
20. 36 Street E., McKnight Blvd to 64 Ave. N.	6	14	8	5	15	17	11	3	
21. 4 Street E./C.P.R.	25	24	24	24	24	27	24	25	
22. Deerfoot Tr./Memorial Drive	23	22	23	21	23	22	23	23	
23. 17 Ave. S., Deerfoot Tr. to Blackfoot Tr.	22	12	22	23	22	15	20	14	
24. Crowchild Tr., Old West City Limits to New West City Limits	28	29	28	25	28	27	29	28	
25. 36 Street E., 8 Ave. S. to 17 Ave. S.	26	26	26	27	26	24	25	26	
26. 17 Ave. S., 36 Street E. to 52 Street E.	15	6	20	8	20	10	22	17	
27. 50 Ave. S./ Ogden Road	10	18	12	6	13	14	19	13	#6 Road
28. 26 Ave. Connector, Macleod Tr. to Blackfoot Tr.	29	26	29	29	29	29	25	29	
29. 14 Street W. Southland Drive to Anderson Road	27	28	27	28	27	26	27	27	

CHAPTER FOUR

CASE STUDIES IN MULTIMODAL EVALUATION

Table 6 (Chapter 3) identifies five studies as appropriate for more detailed presentation to represent the state of the practice in various applications:

Intercity Corridors:	Maryland Statewide Commuter Assistance Study (*25*)
Regional:	Honolulu, HALI 2000 Alternative (*26*)
Regional (Screening):	Toronto Mobility Study (*27*)
Urban Corridor:	Salt Lake City State Street Corridor (*28*)
Regional Programming:	San Francisco Area, Metropolitan Transportation Commission's Programming Process (*8*)

Selection of these particular case studies should not be viewed as an endorsement or model for other evaluations; the state of the practice is evolving rapidly in response to ISTEA and other factors. These case studies can, however, provide a reference point for further development.

INTERCITY CORRIDORS: MARYLAND STATEWIDE COMMUTER ASSISTANCE STUDY, 1990 (*29*)

(This study included all major commuter corridors in the state, both intercity and those within major urban areas.)

Overview

Because of increasing levels of congestion and unmet travel needs, the Maryland Department of Transportation (MDOT) undertook a comprehensive, statewide analysis of 24 major travel corridors (*25,29*). These corridors were primarily interurban, except for several within the Washington, D.C. metropolitan area and several within the Baltimore metropolitan area that could be considered intraurban given the sizes of those urban areas. The study was to create a logical process for looking at statewide travel needs. For each corridor, MDOT developed a profile describing the corridor's current conditions and potential; selected a travel forecasting method for predicting future demands on various facilities; identified alternatives that would reasonably reduce congestion levels, enhance development patterns, and recognize commuting trends, opportunities and/or constraints in that corridor; and evaluated the alternatives on the basis of the estimated impacts, each alternative's practicality, and project cost. The alternatives considered in the Maryland corridor study included a full range of transportation options, including highway improvements, HOV lanes, various bus services, light rail, and commuter rail. For each corridor, all reasonable transportation modes and improvements were considered for both short and long term.

MDOT selected a team of consultants led by COMSIS to undertake the project. The nature of the project dictated a great deal of interaction among the consulting team, MDOT, cities, counties, MPOs, the public, and state leaders, including the governor and the legislature. A mix of short- and long-term projects maintained the interest of this diverse group. The overall process benefited from the use of a single trust fund to provide funding for all modes of transportation and a state DOT that is responsible for multimodal projects.

Evaluation Methods

Table 18 shows the uniform evaluation matrix that the Maryland study employed for each alternative. The evaluation criteria began with measures of highway congestion that used screen lines and the associated volume to capacity (V/C) ratios at each screen line. This process was completed for the base year and for various alternatives. Highway level of service was measured in the percentage of highway lane miles operating at various levels of service. Person-miles traveled were calculated for low-occupancy vehicles (LOVs), HOVs, and transit. For the options, transit boardings were also recorded by the type of transit mode. Several other service measures included travel times, and costs included capital operating costs and other measures of cost-effectiveness. Finally, the study considered qualitative measures, including the ability to enhance economic development, whether or not the plan would be compatible with local transportation plans, a fatal flaw evaluation, and special opportunities for right-of-way and other safety issues. On the basis of this evaluation matrix, important findings and recommendations were written for each corridor, including the identification of specific projects or combinations of projects across alternatives.

Based on an assessment of the evaluation matrix, a list of findings was developed to summarize the impacts of alternatives across the evaluation measures. These findings led to specific project recommendations and implementation strategies.

Forecasting Procedures

The travel forecasts were done using the MINUTP software package. The state was represented as 1,491 traffic zones, and the highway network was adapted from existing studies. The transit network represented only premium service in each corridor. A statewide work trip table was developed from regional studies and from the 1980 Census journey-to-work tabulation. Factored travel patterns for the years 1995, 2000, and 2010 were based on population and employment forecasts. A multinomial logit model was employed for mode choice analysis, using coefficients taken from existing studies. The models were applied for daily work trips and then, using factors developed from Washington and Baltimore, were converted into a.m. peak hours. Daily transit mode usage was based on factors from transit operators.

TABLE 18
MARYLAND STATEWIDE COMMUTER ASSISTANCE STUDY: CORRIDOR 19—WESTMINSTER TO OWINGS MILLS (29)
Alternative Evaluation Matrix Year 2010

Quantitative Measures	Base 1985 Network 1985 Trips	No Build 1985 Network 2010 Trips	Null Alt. 2010 Network 2010 Trips	Alt D Highway	Alt E Shoulder Bus Package	Alt G-1 CRR w/o W. Balt.	Alt G-2 CRR to W. Balt.
1. Screenline V/C Ratio							
Screenline 1 (Baltimore Beltway)							
Southbound	0.82	1.19	1.15	1.20	N/A	N/A	N/A
Northbound	0.50	0.94	0.86	0.86	N/A	N/A	N/A
Screenline 2 (Owings Mills)							
Southbound	0.75	1.02	0.99	0.85	N/A	N/A	N/A
Northbound	0.29	0.46	0.44	0.36	N/A	N/A	N/A
Screenline 3 (Baltimore/CRRL)							
Southbound	1.70	2.29	2.23	1.89	N/A	N/A	N/A
Northbound	0.61	1.08	1.05	0.74	N/A	N/A	N/A
2. % of Highway Lane Miles Operating at:							
LOS A	27%	9%	12%	20%	N/A	N/A	N/A
LOS B	14%	5%	15%	6%	N/A	N/A	N/A
LOS C	25%	2%	9%	24%	N/A	N/A	N/A
LOS D	4%	10%	15%	11%	N/A	N/A	N/A
LOS E	20%	18%	17%	8%	N/A	N/A	N/A
LOS F	10%	56%	32%	31%	N/A	N/A	N/A
3. Person Miles Traveled (AM Peak Hr)							
LOV	93,500	252,300	135,200	148,500	—	N/A	
HOV	—	—				N/A	
Transit	—	—	7,800	9,005	8,406	N/A	9,100
Transit Boardings (AM Peak Hr)			2,500	2,700	2,600	N/A	3,600
Express Bus	—	—	—	300	200	N/A	200
CRR	—	—	—		—	N/A	1,200
LRT	—	—	—		2,400	N/A	—
HRT	—	—	—	2,400	—	N/A	2,200
4. % of Commuter Miles carried by:							
LOV Operating at LOS D or Better	54%	10%	33%	44%	N/A	N/A	N/A
HOV	—	—	—	—	N/A	N/A	N/A
Transit	—	—	—	—	N/A	N/A	N/A

TABLE 18
MARYLAND STATEWIDE COMMUTER ASSISTANCE STUDY: CORRIDOR 19—WESTMINSTER TO OWINGS MILLS (*29*) (*Continued*)

Quantitative Measures	Base 1985 Network 1985 Trips	No Build 1985 Network 2010 Trips	Null Alt. 2010 Network 2010 Trips	Alt D Highway	Alt E Shoulder Bus Package	Alt G-1 CRR w/o W. Balt.	Alt G-2 CRR to W. Balt.
5. Travel Times for Selected Locations Westminster to Owings Mills							
LOV	40	57	55	44	N/A	N/A	N/A
HOV					N/A	N/A	N/A
Transit				51	N/A	N/A	N/A
6. VMT (AM Peak Hr)	81,300	219,400	117,500	129,100	N/A	N/A	N/A
Change (from null)				11,600			
7. Capital Cost ($millions)				$232.0	$83.0	$119.0	$163.0
Highway	—	—	—	$221.0	$41.0		
Transit	—	—	—	$11.0	$42.0	$119.0	$163.0
Bus	—	—	—	$11.0	$42.0		
CRR	—	—	—	—	—	$119.0	$163.0
LRT	—	—	—	—	—		
HRT	—	—	—	—	—		
8. Annual Operating Cost ($millions)				$3.3	$3.3	$8.0	$11.0
Highway	—	—	—	$.3	$.1		
Transit	—	—	—	$3.0	$3.2	$8.0	$11.0
Bus	—	—	—	$3.0	$3.2		
CRR	—	—	—	—	—	$8.0	$11.0
LRT	—	—	—	—	—		
HRT	—	—	—	—	—		
9. Annualized Cost per Trip Served Transit Trips Only	—	—	—	$11.70	$32.40	N/A	$20.00
10. Annualized Cost per Trip Mile Served	—	—	—	$1.00	$2.40	N/A	$3.40
11. Ability to Meet 50% Cost/Revenue Ratio	—	—	—	No	No	Yes	No
12. Cost-effectiveness Index (UMTA)	—	—	—	1	1	1	1
13. Enhancement of Access to Existing or Planned Areas of Economic Development	—	—	—	High	Moderate	Moderate	Moderate
14. Compatibility with Local Transportation Plans	—	—	—	Compatible	Compatible	Compatible	Compatible
15. Fatal Flaw Evaluation	—	—	—	OK	OK	OK	OK
16. Right-of-Way Opportunities	—	—	—	I-795	I-795	Railroad	Railroad
17. Other Issues Including Safety	—	—	—	—	—	—	—

1—Measure cannot be calculated based on forecasting methods.

Use of Study Results

The results of the Maryland analysis of 24 major travel corridors serve as a basis for discussion and comment to help address commuter congestion in the state. This analysis was productive because it provided tests of how long-term objectives were fulfilled by each mode. All modes resulted in a considerable, useful framework for defining what might be done in each corridor. This multimodal planning effort also benefited from the cooperative involvement of operations people from all modes.

REGIONAL STUDIES: HALI 2000 ALTERNATIVES—HONOLULU (*26*)

Overview

The HALI 2000 study addressed the transportation needs of Oahu, Hawaii, on a regional level (*26*). The study reviewed major travel corridors and included all reasonable transportation modes. Oahu has been experiencing rapid population, employment, and traffic growth, but because of its confined geography, the island's transportation options are limited. The alternatives considered in this evaluation included the no-build or committed system, transportation systems management (TSM), HOV, highway expansion, bus only, light rail, and rapid transit options.

Evaluation Methods

The evaluation matrix shown in Table 19 describes the added facilities of each alternative and contains various descriptions of the mode choice for each alternative, including some geographical comparisons of mode choice. Table 19 includes measures of the transportation system, including congestion, level of service, safety, and downtown parking. Also included in the table are an estimate of capital and operating costs, a discussion of the financial requirements and sources to support each project, a discussion of the cost-effectiveness of the public transit options, and a description of environmental impacts, including pollution, energy use, sightliness, and ecosystem damage. The socioeconomic impacts are outlined, followed by community institutional factors, including impact on military bases and staging compatibility with emergency plans. The evaluation matrix is a mixture of quantitative and qualitative factors, with over 60 individual items to be evaluated for each alternative. Because of its large number of evaluation criteria, this method is considered to be one of the most extensive.

These evaluation criteria are established to focus attention on three basic factors: (1) cost-effectiveness, (2) community and/or institutional acceptance, and (3) measures of effectiveness related to transportation goals and objectives.

Forecasting Procedure

Forecasts for the project were performed with the Oahu MPO's regional transportation model for the year 2000. Separate models are used for tourist travel because the impact of such trips is significant.

Use of Study Results

The HALI 2000 project was performed to update Oahu's Long-Range Transportation Plan. The results of the HALI 2000 project were presented to the public through newspaper ads, a telephone survey, and numerous presentations. The results of public reaction were provided to policy makers who developed a recommended long-range plan known as HALI 2005. After additional public reaction, the plan was adopted as the regional plan in June of 1991.

REGIONAL SCREENING: TORONTO MOBILITY STUDY (*27*)

Overview

This study, conducted for the greater Toronto area, had three objectives: (1) to provide an integrated perspective on mobility, (2) to describe economic and social implications of quality transportation, and (3) to identify opportunities for enhancing mobility in the greater Toronto area (*27*). The study was essentially a broad overview of mobility options for the area that evaluated generic strategies rather than projects specific to a location. The strategies considered in the study included demand management, supply management, and financing options.

Evaluation Methods

The evaluation, or in this case, the screening, of transportation improvements is shown in Table 20. The criteria were divided among transportation, socioeconomic (which also includes environmental), and cost categories. Scores were assigned to each strategy across each of the criteria. The criteria were equally weighted, and the overall score was summed. An understanding of the exact context of a particular application would provide a more accurate evaluation of the supply of transportation services.

The evaluation screening resulted in short- and long-term priorities for the generic opportunities identified. For example, in the short term, "improved commuter rail" and "private sector funding of rail transit" were identified as high-priority options. For the long term, "land use mix and density" and "rapid transit improvement" were high priorities. Based on this evaluation, packages of mobility enhancement measures were developed.

Use of Study Results

The information taken from the screening procedures was discussed with officials, and a refined package of mobility enhancement options was developed. These results will provide a broad strategic overview of transportation options in the Toronto area.

URBAN CORRIDOR: I-15/STATE STREET CORRIDOR ALTERNATIVES ANALYSIS—SALT LAKE CITY

Overview

A multimodal transportation study was conducted on the I-15 corridor south of Salt Lake City to evaluate 12 alternatives to

TABLE 19
SUMMARY OF EVALUATION MEASURES: HALI 2000 ALTERNATIVES (*26*)

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
EXPANDED FACILITIES/ SERVICES								
1. Added Highway Lane Miles	-	-	-	84	0	0	0	0
2. Added HOV Lanes (Miles)(a)	-	-	23	5	0	0	0	0
3. Transit System (Total)								
a. Weekday Vehicle Miles of Service	44,000	70,000	100,000	69,000	92,000	58,000	60,000	73,000
b. Facilities on Separate Right of Way (Bus & Rail)	-	-	0	0	0	18.3	21	13.8
c. Reserved Transit Lanes within Roadways	-	-	0	0	28	10.4	7.6	0
TRAVEL MODE CHOICE								
1. Weekday Resident Person Trips by:								
a. Public Transit (b)	176,000	238,200	+23,800	-4,100	+10,100	-200	-4,400	+20,300
b. Carpools (b) (3+ Occupants)	540,500	681,500	+17,700	-3,700	-1,500	+900	+600	-4,300
c. Single Occupant Autos (b)	780,300	965,200	-38,400	+7,200	-5,800	-800	+2,600	-10,100
2. Work Trips by Public Transit %	14.9	18.3	21.7	17.7	19.2	18	18	20.9

(a) HOV - High Occupancy Vehicles with 3 or more occupants
(b) Values for alternatives are changes from Committed System.

TABLE 19
SUMMARY OF EVALUATION MEASURES: HALI 2000 ALTERNATIVES (*26*) (*Continued*)

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
TRAVEL MODE CHOICE								
3. Percent Peak Hour Resident Trips by Public Transit to:								
a. Downtown	13.9	15.9	18.9	15.5	16.4	15.6	15.2	16.4
b. Waikiki	11.1	12.9	14.7	12.5	13.5	12.5	12.8	14.8
c. Airport	6.5	8	9.1	7.5	8.3	6	5.4	10.5
4. Percent Person Trips by Public Transit at Corridor/Screenline								
a. Leeward @ Kalauao	6.9	9.5	11.4	8.7	9.9	9.3	9.1	10.6
b. Downtown @ Kapalama	9.1	10.8	13	10.5	11.2	10.8	10.5	12.1
c. Downtown @ Ward	8.7	10.8	12.6	10.6	11.1	10.6	10.3	11.9
d. Downtown @ School	8.6	9.2	11.6	9.1	9.7	8.9	8.5	9.9
TRAVEL SYSTEM PERFORMANCE								
1. Weekday Vehicle Travel								
a. Vehicle Delay(hours)(c)	53,000	82,200	69,400	72,900	80,000	98,700	88,300	77,700
b. Percent Travel on Congested Roadways(c)	10	14	11	13	12	17	13	13
2. Travel Safety (All Modes)								
a. Annual Accidents(c)	-	10,660	+460	-340	+400	+450	+170	-640
b. Annual Injuries(c)	-	8,160	+370	-260	+330	-20	-180	-510
3. Ratio of Peak Hour Traffic to Design Capacity								
a. Leeward @ Kalauao	1.07	1.28	0.95	0.96	1.25	1.28	1.30	1.25
b. Downtown @ Kapalama	1.07	1.16	1.05	0.97	1.12	1.23	1.17	1.12
c. Downtown @ Ward	0.78	0.87	0.78	0.69	0.87	0.95	0.88	0.85
d. Downtown @ School	-	0.90	0.70	0.80	0.86	0.82	0.91	0.87
e. East Honolulu @ Kapakahi	1.23	1.16	1.02	1.16	1.16	1.18	1.16	1.14

(c) For major roadway system; excludes local streets.

TABLE 19
SUMMARY OF EVALUATION MEASURES: HALI 2000 ALTERNATIVES (*26*) (*Continued*)

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
TRAVEL SYSTEM PERFORMANCE								
4. Downtown Parking Spaces or Change from Committed	22,500	27,500	-3,700	+500	-700	+400	+900	-800
COST OF ALTERNATIVES(e)								
1. Capital Costs 1984-2000		229.5	322.6	1675.3	346.6	678.4	785	1168.2
a.Higway(d)		-	12.3	1445.8	15.3	0	0	0
b. Public Transit		229.5	310.3	229.5	331.3	678.4	785	1168.2
2. Year 2000 Operating Costs		86.5	118.2	88.3	109.4	66.1	69.1	75.2
a. Highway(d)		0	0.4	1.8	0.4	0	0	0
b. Public Transit		86.5	117.8	86.5	109	66.1	69.1	75.2
3. Equivalent Uniform Annual Costs (7% Discount Rate)		104.6	143.9	104.6	136.9	117.5	128.1	161.4
FINANCIAL ANALYSIS(e)								
1. Capital Funding								
a. Federal Highway(d)		0	6	10.8	9	0	0	0
b. Federal Transit(d)		183.6	248.2	183.6	250	517	597.2	823.6
c. State & City		45.9	68.4	1480.9	87.6	161.4	187.8	344.6
2. Operations Funding (Year 2000)								
a. Federal Highway(d)		0	0	0	0	0	0	0
b. Transit Fares		24.2	26.4	23.9	25	24.2	23.9	26.1
c. State & City		62.3	91.4	62.6	84	41.9	45.2	49.1
3. Year 2000 Annual Funding Required from State & City Sources(d)		67.8	100.6	249.9	95.2	61.9	68.7	92.1

(d) Does not include Committed highway projects.
(e) In millions of 1983 dollars.

TABLE 19
SUMMARY OF EVALUATION MEASURES: HALI 2000 ALTERNATIVES (*26*) (*Continued*)

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
PUBLIC TRANSIT								
COST EFFECTIVENESS(f)								
1. Annualized Capital and Operating Costs per Passenger	0.95	1.21	1.53	1.23	1.52	1.36	1.50	1.73
2. Operating Costs per Passenger	0.82	1.00	1.25	1.01	1.22	0.76	0.81	0.83
ENVIRONMENTAL IMPACTS								
1. Year 2000 Daily Emissions (tons)								
a. Carbon Monoxide(b)	-	242.4	-5.0	-10.5	-1.0	+0.2	+1.2	-3.9
b. Hydrocarbons(b)	-	22.2	0	-0.4	+0.3	-0.4	-0.3	-0.6
c. Oxides of Sulfur(b)	-	1.3	0	-0.1	0	+0.1	+0.1	+0.3
2. Energy Consumption (Billions of BTUS)								
a. Year 2000 Operations(b)		20,475	--225	-675	+40	+122	+166	-169
b. Construction (1984-2000)		6,836	9,214	29,714	8,549	18,197	20,519	35,143
3. Visual-Miles Elevated Facilities	-	-	0	5.5	0	0.6	5.7	10
4. Ecosystem-Potential Wildlife Impacts		-	None	Pearl Harbor Crossing Ewa	None	Waiawa & Honouliuli Refuge Units	Waiawa & Honouliuli Refuge Units	None
5. Ecosystem-Potential for Impact to Endangered Plant Species.			None	Ewa	None	Former or&l Alignment	Former or&l Alignment	None

(f) Year 2000 passengers and operations, with costs in 1983 dollars.
Annualized capital costs reflect discount rate of 7%

TABLE 19
SUMMARY OF EVALUATION MEASURES: HALI 2000 ALTERNATIVES (26) (*Continued*)

EVALUATION MEASURE	1980	COMMITTED SYSTEM	A TSM	B HIGHWAY	C BUS	D LIGHT RAIL	E LIGHT RAIL	F RAPID TRANSIT
SOCIOECOMIC IMPACTS								
1. Land Acquisition (Acres)								
a. Residential(g)		-	0	0.5	0	1	0	5
b. Commercial-Industrial(g)		-	24	0.5	24	13.6	15.5	50
c. Agricultural/Public(g)		-	0	70	0	4.1	5.8	8
d. Military		-	0	35	0	0	0	0
e. Total		-	24	106	24	18.7	21.3	63
2. Potential for Parkland Impacts (4f)		-	minimal	1 Park Encroachment	minimal	Potential Encroachmen	Potential Encroachment	Major Encroachment
3. Potential for Historic/ Cultural Facility Impacts		-	minimal		minimal			
4. Significant Reduction in Travel Time to Major Employment		-	minor reduct. in all areas	Ewa, Central Oahu	Transit from Leeward	None	None	Transit from Leeward
5. Project Construction Employment		-	4,600	14,700	4,200	9,000	10,000	17,400
COMMUNITY/INSTITUTIONAL FACTORS								
1. Potential for Adverse Impact on Military Install.		-	Road Pricing	Displacement	None	Minimal	Minimal	Minimal
2. Ease of Staging Improvements		-	Excellent	Poor	Excellent	Good	Good	Fair
3. Ease of Expansion for Projects, Programs & Services		-	Fair	Poor	Good	Excellent	Excellent	Excellent
4. Reinforcement of Area Development Plans		-	Minimal	Encourage growth in Leeward/Oahu	Minimal	Encourage development in primary & secondary urb an centers; encourage densification of urbanized areas		
5. Compatibility with Emergency Plans								
a. Energy Shortage			Good	Fair	Good	Excellent	Excellent	Excellent
b. Natural Disaster			Good	Fair	Good	Poor	Poor	Poor

(g) includes both developed and undeveloped land.

TABLE 20
TORONTO MOBILITY STUDY SCREENING OF IMPROVEMENT OPPORTUNITIES

GENERIC OPPORTUNITIES	TRANSPORTATION CRITERIA				SOCIO-ECONOMIC CRITERIA					COST CRITERIA			OVERALL SCORE
	Pass Cap. Increase/Traffic Flow Improve.	Choice Increase	Demand Reduction	Sub-Total	Emissions Control	Economic Impact	Public Acceptance	Sub-Total	Reduce Goods Movement Costs	Capital Cost	Operating Cost	Sub-Total	
DEMAND MANAGEMENT													
Land Use Mix & Density (Compact Urban Form	1	2	3	6	3	2	1	6	2	3	3	8	20
Parking Pricing/Management/Policies	2	1	2	5	2	2	2	6	2	3	3	8	19
Public Info. on Environment/Energy/Tradeoffs	2	2	2	6	2	1	3	6	2	3	2	7	19
Ride Sharing Programs	2	1	2	5	2	2	3	7	1	3	2	6	18
Flexible/Staggered Work Hours	2	1	2	5	2	1	2	5	2	3	3	8	18
Transit Fare Integration/Schedule Coord.	2	2	1	5	2	2	3	7	1	3	2	6	18
Road Pricing/Tolls	3	2	3	8	2	2	1	5	2	1	2	5	18
Truck Backhaul Matching Service	2	1	2	5	2	2	2	6	2	2	2	6	17
Reduced Off-Peak Transit Fares	1	0	2	3	2	2	1	5	1	3	3	7	15
Truck Road Use Pricing/VWD Regs	2	1	2	5	1	0	3	4	2	2	2	6	15
Nighttime Truck Deliveries	2	0	2	4	2	1	2	5	0	3	1	4	13
CBD Vehicle Restrictions	1	0	3	4	1	1	0	2	2	3	2	7	13
SUPPLY MANAGEMENT													
Improved Commuter Rail	3	3	1	7	3	3	3	9	2	1	1	4	20
Rapid Transit Improvements	3	3	1	7	3	3	3	9	2	0	1	3	19
Improved Real-Time User Info.	3	2	1	6	2	2	3	7	2	2	2	6	19
Express Bus Extensions to Gateway	2	3	2	7	2	2	2	6	2	2	1	5	18
HOV Lanes/Transit Priority	2	2	2	6	2	2	2	6	2	1	2	5	17
More One-Way Arterial Streets	2	1	1	4	2	2	1	5	2	3	3	8	17
New/Improved Arterials and Expressways	3	2	1	6	1	3	2	6	3	0	2	5	17
Computerized Traffic Management Systems	2	2	1	5	2	2	3	7	2	1	2	5	17
Improved Traffic/Transit Operations & Control	2	1	1	4	2	2	3	7	2	2	2	6	17
Expanded Off-Street Loading Facil/Curb Mgmt	3	1	1	5	2	2	2	6	2	1	2	5	16
New By-pass Highway (414)	3	2	0	5	2	2	2	6	3	0	2	5	16
Designated Truck Lanes/Routes	2	1	2	5	2	2	1	5	2	1	2	5	15
Signed Hospital Access Routes	1	1	1	3	1	2	2	5	1	2	3	6	14
FUNDING/IMPLEMENTATION													
Private Sector Funding Rail Transit	2	2	1	5	2	3	2	7	2	3	2	8	20
New Road Taxes Dedicated to Transit Improv.	2	2	1	5	2	3	2	7	1	3	2	6	18
Employer Tax Break for Subsid. Transit Passes	1	1	2	4	2	1	3	6	2	3	2	7	17
Increased Traffic Enforcement	2	1	1	4	2	2	2	6	2	3	2	7	17
Employer Tax to Fund Transit	2	1	1	4	2	0	2	4	2	3	2	7	15
Parking Tax	1	0	2	3	2	2	0	4	2	3	2	7	14

Rating Scale: 0=Unfavorable
1=Neutral
2=Favorable
3=Highly Favorable

improve transportation in the corridor (*28*). These alternatives included no-build, TSM options, bus, additional general purpose freeway lanes, combinations of general purpose freeway lanes and HOV lanes, light rail in two alignments, and a combination of light rail and general purpose freeway lanes. The project was conducted jointly by the FHWA, UMTA, the Utah Department of Transportation (UDOT), the Utah Transit Authority (UTA), and the Wasatch Front Regional Council.

Evaluation Methods

The basic evaluation method was an extension of the traditional UMTA (now FTA) alternatives analysis process, which produces the draft EIS required by federal law. The evaluation considered five major categories: (1) cost, (2) effectiveness, (3) impacts to the natural and socioeconomic environments, (4) financial and institutional feasibility, and (5) cost-effectiveness. Table 21 shows a condensed representation of 5 of the 12 alternatives in the evaluation matrix used in this alternatives analysis. The table shows that costs were divided into capital costs; annual operating costs; total annualized costs; and measures of travel time savings for transit, HOV, and highway users. The effectiveness measurement (i.e., the effectiveness of transportation system performance) was measured by indications of service use by specific mode, such as annual transit trips or mode split for work trips. Effectiveness was also measured by level-of-service indicators that reflected V/C ratios and speeds for critical lengths along the I-15 facility. Automobile and transit travel times were also included, along with several other items. Level-of-service indicators for key intersections are presented in the table.

The third evaluation category was impacts to the natural and socioeconomic environments, which can also be seen in Table 21. These criteria were measured somewhat qualitatively, as opposed to the highly quantitative measures of the first two categories. Social and economic concerns included the proposed alternative's ability to match existing regional plans, the project's possible disruption to residences and businesses, and the project's effect on the business environment and development in the corridor, including employment impacts and effects on tax bases. Visual impacts, impacts on parklands, cultural resources, and construction impacts were also evaluated in this section under typical EIS measures.

The fourth category, financial feasibility, included the development of forecasts for sources of revenues for capital improvements and sources of revenues for continued operation and maintenance of the facility once it had been built. This category assessed potential deficits and evaluated the likelihood that these deficits could be overcome. Also included in this section was an assessment of the equity of the project, its relationship to the benefits, and the burdens to the population in Salt Lake City. The final section dealt with cost-effectiveness and presented various indices, some required by federal agencies for evaluation purposes, others to enhance the evaluation locally.

The evaluation process used in this study is probably best described as subjective, individualized, and consensus seeking. The evaluation process developed information on a range of criteria and performance measures and presented this information in printed reports (draft EIS, technical reports, summaries, and a newsletter) and presentations. Though there was a great deal of objective information, each individual made a decision on which alternative to select based on a subjective assessment of the information and the relative importance of specific measures. The individuals then met and compromised on an alternative that was acceptable to the groups involved.

An examination of the alternative selected indicates that the most important criteria dealt with the performance of the individual modes. Each of those involved seemed to be most influenced by how well the part of the system he or she was responsible for performed. For example, total ridership was critical to the transit representatives, and freeway level of service was most important to the highway representatives. Cost or cost-effectiveness and performance of the other modes was secondary. As a result, the compromise on an alternative that included both highway and transit improvements was not surprising.

The groups involved in the evaluation included the following:

- UDOT technical staff and FHWA technical staff (planning, traffic, construction, etc.)
- State Transportation Commission (politically appointed board)
- UTA management and staff (planning and operations)
- UTA Board of Directors (politically appointed board)
- Local government leaders (mayors, planners, and public works)

Forecasting Procedures

The forecasts for this alternatives analysis used the existing modeling procedures maintained by the regional planning agency. The trip generation and trip distribution models were calibrated using data collected in a 1960 home interview survey. The home-based-work mode choice model was calibrated with data from the 1980 Census Urban Transportation Planning Package. Nonwork transit ridership estimation consisted of applying a set of factors based on trip length to work-trip shares. The Urban Transportation Planning System (UTPS) software was used to process the highway and transit networks.

Use of Study Results

UDOT and UTA adopted as the preferred alternative an option that included both transit improvements and highway improvements. The two organizations have independently undertaken the next steps to implement the adopted alternative, which include completing the environmental process and beginning the engineering design.

Both organizations have also taken steps to secure the necessary funding to implement their respective projects. The Salt Lake County Commission authorized a public vote on a 1.4 of 1 percent increase in the local option sales tax from public transit to fund the transit project. The vote was held in November of 1992 and was defeated. UTA is evaluating alternative approaches that would not require a tax increase. UDOT has prepared a financing package that it plans to present to the 1994 Utah Legislature.

REGIONAL PROGRAMMING: METROPOLITAN TRANSPORTATION COMMISSION'S PROGRAMMING PROCESS—SAN FRANCISCO BAY AREA (*30*)

Overview

In November of 1990, the Metropolitan Transportation Commission (MTC) for the San Francisco Bay Area submitted a regional

TABLE 21
I-15/STATE STREET CORRIDOR ALTERNATIVE ANALYSIS, SALT LAKE CITY (*28*)

Evaluation Measure	Alternative 1* (No Build)	Alternative 2 Rehab I-15/ Best Bus	Alternative 3 1 Lanes I-15/ Best Bus	Alternative 4 2 Lanes I-15/ Best Bus	Alternative 9 1 Lane I-15 UPRR LRT
I. COST					
A. TOTAL CAPITAL COST					
1. Total Capital Cost					
a. 1987 Dollar (Millions)	$57	$283	$437	$526	$574
b. Current Dollars (Millions)	69	392	575	711	729
2. I-15 Improvements (1987 $ Millions)					
a. TSM Improvements	$10.07	$10.07	$10.07	$10.07	$10.07
b. SR 201/I-15/I-80 Interchange Improvements	—	23.11	92.95	95.96	92.95
c. Freeway Mainline Improvements (New)	—	—	54.61	112.58	54.61
d. Structure Replacement	—	103.83	92.15	93.29	92.15
e. Pavement Replacement	—	56.04	51.13	48.18	51.13
f. Improve Existing Interchange	—	—	17.53	46.33	17.53
g. New Interchanges	—	—	29.89	30.90	29.89
h. Special I-215 HOV Access Ramps	—	—	—	—	—
Total	$10.07	$193.05	$348.33	$437.31	$348.33
3. Transit Improvements (1987 $ Millions)					
a. SRTP Improvements	$39.13	$39.13	$39.13	$39.13	$39.13
b. LRT Construction, ROW & Mitigation Allowance	—	—	—	—	101.69
c. Special Park-and -Ride Lots	—	—	—	—	12.88
d. Light Rial Transit Vehicles	—	—	—	—	24.20
e. Light Rail Transit Maintenance Facility	—	—	—	—	8.62
f. Standard Transit Buses	6.13	38.68	37.80	37.80	29.40
g. Transit Buses Maintenance Facility	1.96	12.38	12.10	12.10	9.41
Total	$47.22	$90.19	$89.03	$89.03	$225.33
4. Total Equivalent Annual Capital Cost (1987 $ Millions)					
a. Total	$8.04	$35.35	$53.34	$63.76	$67.45
b. I-15	1.18	22.59	40.75	51.17	40.75
c. Transit	6.86	12.75	12.59	12.59	26.70
B. ANNUAL O & M COST (1987 $ Millions)					
a. Total	$29.26	$41.86	$41.92	$41.90	$45.20
b. I-15	1.38	1.38	1.68	1.85	1.68
c. Transit	27.88	40.48	40.24	40.05	43.52
C. TOTAL ANNUALIZED COST (CAPITAL AND O& M) (1987 $Millions)					
a. Total	$37.30	$77.20	$95.26	$105.66	$112.65
b. I-15	2.56	23.97	42.43	53.02	42.43
c. Transit	34.74	53.23	52.83	52.64	70.22
D. ANNUAL TIME COST SAVINGS TO TRANSIT RIDERS (COMPARED TO ALTERNATIVE 3) (2010) ($ Millions)	N/A	—	0	—	$3.03
E. ANNUAL TIME COST SAVINGS TO HOV USERS (COMPARED TO ALTERNATIVE 3) (2010) ($ Millions)	—	—	0	—	—
F. ANNUAL TIME COST SAVINGS TO HIGHWAY USERS (COMPARED TO ALTERNATIVE 2 (2010) ($Millions)	—	0	$0.34	$0.73	$0.56
II. EFFECTIVENESS (TRANSPORTATION SYSTEM PERFORMANCE)					
A. UTILIZATION BY MODE					
1. Daily Transit Person-Trips (2010) (Linked) (Thousands)	87.77	100.10	99.68	99.79	105.80
2. Daily Work Trips, by Mode (2010) (Millions)					
a. Transit (linked)	47.41	55.20	54.78	54.89	58.29
b. HOV (3+ persons)	59.56	58.73	59.05	59.06	58.82
c. Auto (1 and 2 persons	822.7	815.8	815.8	815.8	812.6
3. Annual Transit Trips (2010) (Millions)					
a. Linked	23.91	27.22	27.11	27.14	28.77
b. Unlinked	29.88	34.03	33.89	33.93	37.37
4. Daily "Guideway" Passengers (2010)					
a. Rail	—	—	—	—	23,400
b. Express Bus and HOV on I-15	3,100	4,200	4,100	4,100	—

transportation improvement program (TIP) based on a multimodal programming process (*8*). Since that early effort, the MTC has continued to develop its method and has applied it to recent programming efforts (*30*). This new method is a response to ISTEA requirements and local needs that was established in the spring of 1992 for the 1993 TIP. Prioritized projects range from highway paving to child-care facilities at transit stations.

In developing the process, the MTC consulted all relevant agen-

TABLE 21
I-15/STATE STREET CORRIDOR ALTERNATIVE ANALYSIS, SALT LAKE CITY (*28*) (*Continued*)

Evaluation Measure	Alternative 1* (No Build)	Alternative 2 Rehab I-15/ Best Bus	Alternative 3 1 Lanes I-15/ Best Bus	Alternative 4 2 Lanes I-15/ Best Bus	Alternative 9 1 Lane I-15 UPRR LRT
5. Mode Split for Work Trips (2010)					
a. % Transit	5.10%	5.94%	5.89%	5.90%	6.27%
b. % HOV (3+ persons)	6.41	6.31	6.35	6.35	6.33
c. % Auto (1 and 2 persons)	88.49	87.75	87.76	87.75	87.40
6. Mode Split to Downtow SLC (2010) (Work Trips)					
a. % Transit	21.9%	23.9%	23.8%	23.8%	23.9%
b. % HOV (3+ persons	7.5	7.5	7.5	7.5	7.5
c. % Auto (1 and 2 persons)	70.6	68.6	68.7	68.7	68.6
B. LEVEL OF SERVICE (LOS)					
1. I-15 Volumes, V/C ratio, LOS and AM Peak Period Speeds at Selected Locations for the General Purpose Lanes					
a. 7200 South - 9000 South					
Volume	5,726	5,726	6,736	7,432	6,736
V/C	1.08	1.08	0.95	0.84	0.95
LOS	F	F	E	D	E
Speed (mph)	<30	<30	43	51	43
b. 3300 South - 4500 South					
Volume	5,655	5,655	7,244	8,455	7,244
V/C	1.07	1.07	1.03	0.96	1.03
LOS	F	F	F	E	F
Speed (mph)	<30	<30	<30	40	<30
c. 1300 South - 2100 South					
Volume	4,818	4,818	5,767	6,195	5,767
V/C	0.68	0.68	0.65	0.70	0.65
LOS	C	C	C	C	C
Speed (mph)	56	56	56	55	56
2. Automobile Travel TImes in AM Peak (Minutes)					
a. Sandy to CBD	31	31	30	29	30
b. West Jordan to Fashion Place Mall	11	11	9	9	9
c. Sandy to South Salt Lake	23	23	23	23	23
3. Transit Travel Tiems (Minutes)					
a. Sandy to CBD	55	57	57	56	51
b. West Jordan to Fashion Place Mall	33	33	33	33	36
c. Sandy to South Salt Lake	53	51	51	51	50
4. Vehicle Miles Traveled (VMT) Per Day on Congested Roadways (V/C>.9): I-15 Northbound (AM Peak Hour) (Thousands of Miles)	56.7	56.7	63.7	67.2	63.7
5. Total Miles of Congested Roadway (VC>.9) (AM Peak Hour) (Corridor Area)					
a. Total Miles	25.15	25.15	22.18	21.27	22.18
b. I-15 Miles	10.88	10.88	9.35	9.06	9.35
6. LOS for Key Intersections					
a. North Temple and I-15 (New Interchange)	Alternatives 1, 2: Not included		Alternatives 3,9: F for Alternative I Design; D for Alternative II Design		
b. CBD Intersections	9 Intersections: 2, at LOS A, 2 at LOSB, 2 at LOS C, 1 at LOS D, 2 at LOS E		Compared with 1, 2, 7, 8: • 7 are same LOS • 1 improves from D to C • 1 worsens from E to F		
c. Local Street to Local Street Intersections	31 Intersections were selected for comparison: 1 at LOS A, 3 at LOS B, 14 at LOS C, 8 at LOS D, 2 at LOS E, 3 at LOS F		Compared with 1, 2, 7, 8: • 21 are same as LOS • 5 improve • 5 worsen Of the 31 intersections: 2 at LOS A, 3 at LOS B, 14 at LOS C, 4 at LOS D, 5 at LOS E, 3 at LOS F		
	Alternative 4: E for Alternative I Design; D for Alternative II Design Compared with 1, 2, 7, 8: All are same LOS Compared with 1, 2, 7, 8: • 18 are same LOS • 4 improve • 9 worsen Of the 31 intersections: 2 at LOS A, 3 at LOS B, 10 at LOS C, 9 at LOS D, 3 at LOS E, 4 at LOS F				

TABLE 21
I-15/STATE STREET CORRIDOR ALTERNATIVE ANALYSIS, SALT LAKE CITY (*28*) (*Continued*)

Evaluation Measure	Alternative 1* (No Build)	Alternative 2 Rehab I-15/ Best Bus	Alternative 3 1 Lanes I-15/ Best Bus	Alternative 4 2 Lanes I-15/ Best Bus	Alternative 9 1 Lane I-15 UPRR LRT
d. Local Street to I-15 Interchanges Existing Interchanges: 3300 South, 4500 South, 5300 South, 7200 South, 9000 South, 10600 South	6 Interchanges: 1 atr LOS D, 5 at LOS F	6 Interchanges: 2 at LOS D, 1 at LOS E, 3 at LOS F	Compared with Alternative 2: Of the 6 existing interchanges: • 2 improve • 4 the same	Compared with Alternative 2: Of the 6 existing interchanges: • 5 improve • 1 the same	Compared with Alternative 2: Of the 6 existing interchanges: • 3 improve • 3 the same
New Interchanges: (i) North ztemple (ii) 11400 South Overall: • 1 at LOS D • 5 at LOS F			For the 2 New Interchanges: (i) at LOS D (ii) at LOS C Overall: • 1 at LOS C • 1 at LOS D • 1 at LOS E • 2 at LOS F	For the 2 New Interchanges: (i) at LOS D (ii) at LOS C Overall: • 3 at LOS C • 5 at LOS C	For the 2 New Interchanges: (i) at LOS D (ii) at LOS C Overall: • 4 at LOS C • 1 at LOS D • 1 at LOS E • 2 at LOS F
III. IMPACTS TO NATURAL AND SOCIOECONOMIC ENVIRONMENTS					
A. NATURAL ENVIRONMENT 1. Geologic Hazards	Seismic activity in the area will affect all alternatives similarly				
2. Natural Resources/Wate Quality/Vegetation/Wildlife	No Impact	All alternatives would involve possible removal of mature trees and landscaping. Disrupted wildlife would return to corridor on tier own accord after construction phase. Water quality and floodplains are not significantly affected.			
3. Soils and Agriculture	No Impact		Removes 2 acres of prime agricultural soil		Same as Alternative 7
4. Wetlands	No Impact		Will potentiall displace or disrupt 18.6 acres of wetlands		
5. Air Quality	No reduction in regional pollutant burden		All build alternatives will reduce regional poluutant burden by a minor amount		
6. Noise	No Impact		I-15 alignment potentially impacts 38 noise sensitive sites	Same as alternative 3	UPRR and I-15 alignment potentially impacts 65 noise sensitive sites
7. Energy	No reduction in energy consumption or saving travel costs	Minor reduction i nenergy consumption and saving travel costs	Daily Savings 263 barrels of oil $44,000 travel costs	Daily Savings 317 barrels of oil $44,500 travel costs	Daily Savings 333 barrels of oil $60,000 travel costs
B. SOCIOECONOMIC ENVIRONMENT 1. Land Use and Planning	Does not conform with regional and local transportation plans	Complies only slightly with regional and local plans for improving	No significant impact to local planning.		
2. Displacement Residences/Business	No Impact		Will displace: 4 acres 2 residences 0 mobile homes 0 businesses	Same as Alternative 3	Will displace: 49 acres 8 residences 1 mobile home 9 businesses
3. Economics and Development	No change for existing development along I-15 trends would continue		Minor enhancement of development along I-15 specifically near interchanges		
4. Joint Development Potential	—	—	—	—	2 sites
5. Employment Impact (Employees) (due to transit) a. Short-Term (during construction) b. Permanent	— 1,000	— 1,500	— 1,500	— 1,500	530 1,500

cies and interest groups. These agencies and groups were partners with MTC in the development and application of the programming process. MTC staff credit the success of the effort to an open participatory approach at every level.

Evaluation Methods

Three sets of criteria were used by the MTC to program projects in the Bay Area. These criteria groups were used sequentially—

TABLE 21
I-15/STATE STREET CORRIDOR ALTERNATIVE ANALYSIS, SALT LAKE CITY (*28*) (*Continued*)

Evaluation Measure	Alternative 1* (No Build)	Alternative 2 Rehab I-15/ Best Bus	Alternative 3 1 Lanes I-15/ Best Bus	Alternative 4 2 Lanes I-15/ Best Bus	Alternative 9 1 Lane I-15 UPRR LRT
6. Net Fiscal Impact					
a. Construction-Related	—	—	—	—	$14M/yr
b. On-Going	—	—	—	—	$11M/yr
c. Property Tax Base Effects due to Light Rail (incremental annual revenues in $ millions)	—	—	—	—	$1.02 to $1.06
7. Local Traffic Impact	Alternatives 1, 2, 7, 8		Alternatives 3, 4, 5, 6, 9, 10, 11, 12,		
a. North Temple Interchange	Interchange not included		• Better access to CBD. Without interchange, all interchanges north of North Temple would be negatively impacted. • Traffic in lower Avenues impacted. Traffic on 2nd Avenue expected to increase 7%. • Capitol Hill area would benefit by a reduction of approximately 20 % in overall traffic.		
8. Visual	No Impact		New Interchages at 11400 South and North temple represent an intrusion into the visual environment.		
9. Parklands	No Impact				Ball field
10. Cultural Resource/Historic Sites	No Impact		Displaces two residences potentially eligible for National Register		8 residences 3 businesses
11. Construction (Temporary)	No Impact	All build alternatives would similar temporary construction impacts. Disruption and reduced patronage to business adjacent alignments. Ahort-term economic gains due to influx of workers and purchase of supplies. Increase to truck traffic in the l;ocal area. Other impactswould include increase dust, noise, and traffic conflicts. Restricted access due to detours and construction activities. Increased energy consumption.			
IV. FINANCIAL AND INSTITUTIONAL FEASIBILITY					
A. SOURCES OF REVENUES FOR CAPITAL IMPROVEMENTS					
1. Forecast of Revenue to 2010 from Existing SOurces (UMTA Section 3 at 50%) (Current $ Millions)					
a. Total	$69	$374	$557	$563	$634
b. I-15	11	255	438	444	438
c. Transit	58	119	119	119	196
2. Potential Deficit to 2010 (comparison of capital costs to revenues) (UMTA Section 3 at 50%) (Current $ Millions)					
a. Total	$0	$18	$18	$148	$95
b. I-15	0	0	0	130	0
c. Transit	0	18	18	18	95
3. Potential Deficit as a Percentage of Capital Costs (2010) (UMTA Section 3 at 50%)					
a. Total	0%	4.6%	3.1%	20.8%	13.0%
b. I-15	0	0	0	22.6	0
c. Transit	0	13.1	13.1	13.1	32.6
4. Forecast of Revenues from Potential New Sources, by Mode	Information not available				
B. SOURCE OF REVENUES FOR O & M					
1. Forecast of Revenues from Existing Sources, (Current $ Millions)	$3.84	$3.84	$4.68	$5.16	$4.68
a. I-15 - Annual O & M Cost in 2009-2010	1,284	1,326	1,325	1,325	1,352
b. Transit - Total O $+& M Revenues Through 2010					
2. Potential Deficit (comparison of O & M costs to revenues) (2010) (Current $ Millions)	$ 0	$ 0	$ 0	$ 0	$ 0
b. I-15	(205) surplus	90	86	81	200
c. Transit (%)					
3. Potential Deficit as a Percentage of O & M Costs (2010)	0%	0%	0%	0%	0%
b. I-15	(19.0) surplus	6.4	6.1	5.8	12.7
c. Transit (%)					
4. Forecast of Revenues from Potential New Sources, by Mode	Information not available				

TABLE 21
I-15/STATE STREET CORRIDOR ALTERNATIVE ANALYSIS, SALT LAKE CITY (*28*) (*Continued*)

Evaluation Measure	Alternative 1* (No Build)	Alternative 2 Rehab I-15/ Best Bus	Alternative 3 1 Lanes I-15/ Best Bus	Alternative 4 2 Lanes I-15/ Best Bus	Alternative 9 1 Lane I-15 UPRR LRT
C. EQUITY PF BENEFIT AND BURDEN 1. Incidence of Financing Burden, by Population Subgroup and/or Area	IV A2 and IV B2 provide the projected shortfalls for all alternatives. There is no shortfall for Alternative 1, and all other shortfalls could be funded by one or more of the sources . This table provides equity issues associated with each revenue sources.				
2. Incidence of Natural and Socioeconomic Impact by Population Subgroup and/or Area a. I-15	No Impact	All alternatives which include a new freeway interchange at North Temple potentially impact three adjacent neighborhoods: Jackson, Guadaloupe and Euclid. Traffic in the lower Avenues, especially 2nd Avenue, will increase while traffic in the Capitol Hill area will be reduced			
b. Transit	No Impact				
V. COST EFFECTIVENESS					
A. UMTA-REQUIRED INDICES 1. Federal Cost-Effectiveness Index (2010) ($ per new rider)	N/A	N/A	0	N/A	$4.40
2. Total Cost-Effectiveness Index (2010) ($ per new rider)	N/A	N/A	0	N/A	$8.65
B. CAPITAL COST-EFFECTIVENESS COMPARISON 1. Capital Cost/Passenger (Transit and HOV) ($ per passenger)	$ .29	$ .47	$ .46	$ .46	$ .93
C. O & M COST-EFFECTIVENESS COMPARISON 1. O & M Cost/Passenger (Transit and HOV) (2010) ($ per Passenger)	$ 1.17	$ 1.49	$ 1.48	$ 1.48	$ 1.51

*Evaluation included 12 alternatives

first, to screen projects, next to assign a score based on a project's merits, and finally to ensure overall program effectiveness. A discussion of each of these criteria follows.

Step 1: Screening Criteria

Each project had to meet certain threshold requirements before it could be considered for the next stage of the process. The screening criteria were placed in five groups:

- Consistency requirements — These criteria ensure that the project meets all requirements of ISTEA and US DOT regulations, including the necessary involvement of all agencies and other interested parties in the planning process. These criteria also include factors such as consistency with the regional transportation plan, land use plans, ISTEA, air quality plans, etc.
- Financial requirements — Projects are required to have reasonable cost estimates and financial plans that identify the source of funds and cash flow. All local contributions must be affirmed by the responsible local authority. The projects must also be feasible, given projected regional funding.
- Project-specific requirements — These criteria provide considerations of the project's definition and justification, its completeness of project documentation, the project's phasing, and its compliance with various ISTEA requirements.
- Air quality requirements — At this stage projects are not required to have certified environmental documents, but those that do must show no significant unmitigated negative impacts on regional air quality.
- Americans with Disabilities Act (ADA) requirements — Projects had to comply with ADA.

Step 2: Scoring Criteria

If projects pass the screening criteria, they can then be scored using the information shown in Table 22. This table was developed by a broad-based committee of transportation agencies, regulators, and other interested parties. The MTC staff rated projects using criteria based on information submitted by agencies.

As is shown in Table 22, the criteria are grouped into four major areas. Each area has a number of points assigned to it that are available to be allocated to the lower-level criteria. The sum of a group of criteria cannot exceed the sum allocated to the major criteria.

Step 3: Programming Criteria/Principles

After project scoring was complete, another set of criteria was used to ensure that the overall program increased mobility, provided for clean air, leveraged resources, and was equitable. Ensuring overall program compliance with the federal Clean Air Act was an important consideration.

The following criteria were used to establish the final program:

- Project merit — based primarily on the score that the project received in step 2
- Project readiness — projects were programmed as soon as obligation authority was available
- Cost-effectiveness — based on score from step 2 and total cost
- Geographic equity — based on county population over duration of ISTEA
- 50 percent of ISTEA STP funds programmed by counties and 50 percent by MTC
- 100 percent of ISTEA CMAQ funds programmed by MTC with emphasis on addressing most serious air quality problems

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)

Categories are mutually exclusive. Within categories, project points can not exceed the amount assigned for the category.

30		**Maintain/sustain the Metropolitan Transportation System (MTS)**
		Management System based Rehabilitation/Replacements
		Transit capital replacements/rehabilitations based on Short Range Transit Plan (SRTP)
	20	Urgent replacements are defined as projects that are not the result of deferred maintenance, but rather the replacement of assets 20% older than the replacement cycle in the Bay Area Transit Finance
	OR	Plan or 20% above FTA mileage/age requirements, and cost-effective vehicle rehabilitations.
		Normal replacement period for different classes of transit assets is determined largely by the
	30	replacement cycles in the Bay Area Transit Finance Plan. The age requirements are as follows:
		Bus - 12 years
		Van- 4 years
		LRV - 25 years (or FTA approved life)
		Trolley - 18 years
		Heavy rail car (CalTrain and BART)- 25 years
		Locomotive - 25 years
		Ferry/- 30 years
		Tools and equipment - 10 years
		Service vehicle - 7 years
	OR	Track, trolley overhead - varies by type of facility and component replaced
		Facility - examined case by case, using commonly accepted standard practices
		Transit capital rehabilitations that prolong the useful life of the asset.
		Major (more than 50%) - 30 points
	20-30	Significant (40% or more)- 20 points
		FTA will not allow rehabilitations that prolong the life less than 40%.
		Road Projects based on Pavement, Bridge or other Management Systems: Normal pavement rehabilitation
	2-30	cycles will be determined using the MTC PMS rating system for the existing pavement for project on the MTS:
		Optimal rehabilitation - 25 to 50 (poor to very poor) - 30 points if entire project. 20 if significant part, 10 if minor part
		Replacement of a failed road - Less than 25 (very poor/failed)- 20 points if entire project, 10 if significant part, 5 if minor part
		Rehabilitation on road that prolongs good condition- 50 to 70 (good to poor) - 10 points if entire project, 5 if significant part, 2 if minor part
		If a PMS other than MTC's, or another type of management system was used, a comparable interpretation is acceptable.
		Rehabilitation/Replacements NOT based on Management Systems
	5-20	Transit capital replacement/rehabilitation not based on Shod Range Transit Plan. Normal replacement period for different classes of transit assets is determined largely by the replacement cycles in the Bay Area Transit Finance Plan listed above.
		Normal pavement rehabilitation cycles will be determined using the following system for the for projects
	1-20	not on the MTS, but of benefit to the MTS. or not based on a PMS, or for related roadway support infrastructure projects, such as drainage, retaining walls. or obsolete signal controllers (using standards in the Highway Capacity Manual or other standard references):
		Optimal rehabilitation (poor to very poor) - 20 points if entire project, 10 if significant part, 5 if minor part
		Replacement of a failed road - 15 points if entire project. 7 if significant part, 3 if minor part
		Rehabilitation - (good to poor) - 5 points if entire project, 2 if significant part. 1 if minor part
	1-20	Maintain existing publicly owned pedestrian and bicycle facilities:
		Optimal rehabilitation (poor to very poor) - 20 points if entire project, 10 if significant part. 5 if minor part
		Replacement of a failed road - 15 points if entire project, 7 if significant part, 3 fl minor part
		Rehabilitation - (good to poor) - 5 points if entire project. 2 if significant part, 1 if minor part

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)
(*Continued*)

		Seismic retrofit
	30	Whole project is for seismic retrofit purposes and is included in Tier 1 of Caltrans' seismic retrofit list (high risk category) or corrects an identified high risk need
	20	Whole project is for seismic retrofit, but is in lower Tiers of Caltrans list, or has been identified as a lower risk
	10	Seismic retrofit is included as part of a larger project
	0-10	Project is for rehabilitation or replacement 10 prevent unacceptable breakdowns in the MTS
30	**Improve efficiency and effectiveness of MTS**	
		Safety and Security/Transit Security is based on an assessment of the existing safety and security problem and the extent to which the proposed project will reduce such problems on the MTS.
	MULT by	Existing safety or security problem is defined across modes. The impact scores (described below) are multiplied by the following factors to reflect the extent of the existing problem. Major safety or security problem - 0.8 to 1.0 Significant safety or security problem - 0.4 to 0.6 Minor safety or security problem - 0 to 0,2
		The extent to which the project wilt address safety and security problems is addressed by mode. Multimodal projects may score under more than one mode, but a project's safety impact is capped at 20 points.
	0-20	Road Projects: High impact: 16 to 20 points HOV enforcement areas Grade Separations Conversion from expressway to freeway or median barrier, when crossover median accidents are the issue Geometric improvements. shoulders, curve corrections New signals that meet (Caltrans (state highway) or HCM) warrants Medium impact: 8 10 12 points Widenings, auxiliary lanes, left turn pockets Signal interconnect Interchange modifications Bike lockers or racks Low Impact - 0 to 4 points New interchanges
	0.20	Transit Projects: High impact: 16 to 20 points Passenger or employee safety/security project, such as Lighting in high security area Handrails Medium impact: 8 to 12 points Equipment or assets safety/security project, such as Lighting in low security area Bus turnouts/bulbs Maintenance yard fences Low Impact - 0 to 4 points Revenue collection security project

Use of Study Results

MTC used the programming process just described to evaluate over 350 projects in a 4-week period. MTC reports that the process has widespread support in the Bay Area and has received few complaints from agencies and others.

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)
(*Continued*)

	0.20	Pedestrian and bicycle projects: High impact: 16 to 20 points Significant Class 1 bike path or Class 2 bike lane Sidewalks with curb cuts where none exist Curb cuts Resolves conflict between bikes or pedestrians and cars or trains, such as traffic signal actuations Grade separations Medium impact: 8 to 12 points Minor Class 1 bike path or Class 2 bike lane Sidewalk improvement Signage Low Impact - 0 to 4 points Class 3 bikeway or Class 2 bike lane Signage
	MULT by 0-20	**Congestion Relief** is based on an assessment of the existing congestion problem and the impact of the proposed project in reducing such problems. Existing congestion is evaluated across mode by looking at the volume of traffic/number of people affected by the congestion. The impact scores (described below) are multiplied by the following factors to reflect the extent of the existing problem: Major congestion - 0.8 to 1.0 Significant congestion - 0.4 to 0.6 Minor congestion - 0 to 0.2 Multimodal projects may score under more than one mode, but a projects congestion impact is capped at 20 points. Road projects: High impact: 16 to 20 points - Must be on or significantly benefit the MTS HOV lanes CMP Deficiency Plan Measure (in future years) Ramp metering with HOV bypasses Signal interconnect of 8 or more signals Signal interconnect of 8 or more signals that cross jurisdictional boundaries (FETSIM requires 10+) Gap closure with system-wide benefit Interchange that upgrades to freeway (grade separations) Traffic Operations System (TOS) Medium impact: 8 to 12 points On or significantly benefits the MTS, Auxiliary lanes On or significantly benefits the MTS, Left turn pockets or other intersection improvements On or significantly benefits the MTS, Park and ride lots On or significantly benefits the MTS, Signal interconnect of 2 or more signals within a single jurisdiction On or significantly benefits the MTS, New signal where none currently exists and meets warrants On or significantly benefits the MTS, ramp metering without HOV bypasses Connects to MTS, any high impact project type Low Impact - 0 to 4 points New local interchanges Gap closure that moves the bottleneck Not on MTS, any high or medium impact project type

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)
(*Continued*)

	0-20	Transit Projects: High impact: 16 to 20 points -- Must be on or significantly benefit the MTS Significantly reduces transit vehicle crowding (load factor) Increase in service capacity significantly CMP Deficiency Plan Measure (in future years) Increases service reliability significantly Interconnect or fare coordination project Bus turnouts/bulbs Intermodal facility that accommodates major transfers Reduces travel time, including transfer time, significantly Medium impact: 8 to 12 points Increase service reliability minority Interconnect or fare coordination project Reduces load factor off MTS Increases service capacity off MTS Intermodal facility that accommodates significant transfers Reduces travel time somewhat Low Impact - O to 4 points Increases passenger comfort or convenience, such as bike racks Intermodal facility that accommodates an uncertain number of transfers
	0-20	Pedestrian and bicycle projects: High impact: 16 to 20 points --- Must be on or significantly benefit the MTS CMP Deficiency Plan Measure (in future years) Bike path/lane or sidewalk that will primarily serve commuters (i.e. parallel reliever route) Sidewalks where none exist (gap closure that connects to transit center) Projects that interconnect across jurisdictional boundaries Medium impact: 8 to 12 points Bike path/lane with mixed commuter or other non-recreation use or connects to MTS Usable sidewalk segments, including upgrades and new installations Sidewalks where none exist (gap closure that connects to activity center) Low Impact - 0 to 4 points Bike path/lane or sidewalk that is primarily for recreational travel or not on MTS Signage
	0- 10	**Cost effectiveness - and life cycle costs** will be measured by taking the total project score and dividing it by the total project cost, and then normalizing to achieve scores between 0 and 10. This is a proxy for a cost benefit analysis. In future programming cycles, improvements in measurement techniques for project benefits wit! be incorporated, if available.
	0-20	Projects which **improve freight movement** will be rated according to the following scale: Project is on a truck route Heavy trucks are more than 25% of traffic flow - 20 points Heavy trucks are between 10 and 25% Of traffic flow- 10 points Heavy trucks are less than 10% of traffic flow - 0 to 5 points
	0- 30	Intermodal freight facilities Major facility that serves the MTS (i.e. makes a major reduction in the amount of time required for a freight container to transit through the region) - 25 to 30 points Minor facility that serves the MTS (i.e. reduces the amount of time required for a freight container (or cargo) to transit through the region) - 15 to 20 points Facility net tied to the MTS - 5 to 10 points

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)
(*Continued*)

15	**System Expansion**	
		System expansion projects will first be evaluated as to whether or not they meet demand. Current demand will be given a higher priority than projected demand. Examples of how demand can be demonstrated include, but are not limited to, LOS data, volumes, load factors for transit, or subjective criteria such as empirical observation. Support in established planning documents such as Short Range Transit Plans, Congestion Management Plans. ADA plans, or other applicable plans or studies will be given the most credence. Then, points will be assigned up to a maximum of 15 points to different project types according to mode. Projects with multimodal aspects are scored as the primary mode of the project.
	MULT by	Demand: Demonstrated high demand - 0.8 to 1.0 Medium demand - 0.4 to 0.6 Low demand - 0 to 0.2 No documentation as to demand for project - 0
	0 - 15	Road Projects *(Note: these are additive.)* HOV lanes - 5 points Mixed flow capacity, including arterials - 0- 2 points Supporting features such as ramp metering, park and rides. bus routes, bicycle and pedestrian facilities - 1 to 5 points On or significantly benefits the MTS - 5 points Minor benefit to the MTS - 2 to 3 points
	0 - 15	Transit Projects Significant expansion on or significantly benefits the MTS, including supporting features- 15 points Minor expansion, on or benefits the MTS, supported by the SRTP - 2 to 10 points
	0-15	Intermodal freight facilities expansion: Access to major freight distribution facilities - 15 points Access to minor freight distribution facilities - 2 to 10 points Access to containerized cargo port as defined by Seaport Plan- 10 to 15 points Access to other seaport as defined by the Seaport Plan- 4 to 6 points Access to air carrier airport - 10 to 15 points Access to airport with more than 100,000 operations per year- 4 to 6 points Access to other airports - 0 to 2 points
	0-15	Bicycle/pedestrian commuter expansion: Bike path/lane or sidewalk that will primarily serve commuters (i.e. parallel reliever route) - 10 to 15 points Bike path/lane with mixed commuter and other non-recreation use or connects to MTS - 4 to 6 pts Bike path/lane or sidewalk that is primarily for recreational travel or not on MTS - 0 to 2 points
	0-15	Corridor preservation Right-of-way for major endangered transportation corridor, including station sites or future maintenance facilities- 15 points Right-of-way for major transportation corridor, including station sites or future maintenance facilities -10 points Right-of-way for minor transportation corridor - 0 to 5 points

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)
(*Continued*)

25	External Impacts	
		Projects which will produce an improvement in Air quality over the life cycle of the project will be awarded points according to the following system:
	5	Adopted federal Transportation Control Measures (TCMs) required to bring the MTC region into compliance with the federal Clean Air Act.
		Projects with demonstrable air quality improvement impact based on analysis performed for the 1991 Clean Air Plan (includes both federal (FTCM) and state (STCM) measures). Projects may score under several subcategories if multiple TCMs are included in the project, up to a cap of 20 points for TCM inclusion:
	0-20	Most effective TCMs (Group 1): Signal timing (FTCM 24 and 25). Market based measures (STCM 22), Ozone Excess 'no Drive Days" (STCM 23) Entirely a TCM - 20 points Includes a TCM as a significant part - 15 points Includes a TCM as a minor part - 10 points No significant air quality impact in certified environmental document - 5 points Unknown air quality impact - 0 points
	0-15	Highly effective TCMs (Group 2): Incident Management (FTCM 26), Employer based Trip Reduction Rule (STCM 2), Install Traffic Operations System (STCM 11), Implement Revenue Measures (STCM 21) Entirely a TCM - 15 points Includes a TCM as a significant part - 12 points Includes a TCM as a minor part - 8 points No significant air quality impact in certified environmental document - 5 points Unknown air quality impact - 0 points
	0-10	Moderately effective TCMs (Group 3): Regional Transit Coordination (Translink and regional 800 transit phone number)(FTCM 21), Expand and Improve Public Transit (rail station improvements/intermodal stations, purchase of clean fuel buses for fleet expansion)(FTCM 3), Improve transit Service (STCM 3), Expand Regional Rail System (STCM 4), Improve Arterial Traffic Flow (STCM 3), Indirect Source Control Program (STCM 16) Entirely a TCM - 10 points Includes a TCM as a significant part - 8 points Includes a TCM as a minor part - 5 points No significant air quality impact in certified environmental document - 2 points Unknown air quality impact - 0 points
	0-5	Marginally effective TCMs (Groups 4 and 5): Upgrade CalTrain service (FTCM 19), Regional HOV : System Plan (FTCM 20). Park and Ride lots (FTCM 7, 8), Employer Audits (FTCM 23), Local TSM Initiatives (FTCM 28), all other FTCMs, all other STCMs Entirely a TCM- 5 points Includes a TCM as a significant part - 4 points Includes a TCM as a minor part- 2 points No significant air quality impact in certified environmental document - 1 points Unknown air quality impact - 0 points

TABLE 22
METROPOLITAN TRANSPORTATION COMMISSION'S CRITERIA AND SCORING MEASURES, SAN FRANCISCO BAY AREA (*30*)
(*Continued*)

	0- 10	Supports **land use** plans and goals/strategies consistent with the Regional Transportation Plan. Promotes increased land use density around transit stations Promotes more efficient land use patterns Reduces auto dependence High Impact - 8 to 10 points Meets all three of the above Medium Impact - 4 to 6 points Meets two of the above Low Impact - 0 to 2 points Meets one of the above
	0-10	**Energy conservation/modal shift** Directly promotes modal shift away from the single occupant vehicle such as rail. bus, HOV or bicycle/pedestrian projects- 8 to 10 points Indirectly promotes modal shift, such as TOS, park and ride lots - 4 to 6 points Signal interconnection projects - 4 to 6 points Repaving or new signal projects- 0 to 2 points
	0-20	**Americans with Disabilities Act (ADA) enhancements** Entire project is for ADA- 20 points ADA is a significant component of project - 5 points ADA is a minor component of project - 2 points
	0-15	**Enhancement activities, as defined by ISTEA, beyond required mitigations** are included in the project (Section 133 of ISTEA defines transportation enhancement activities for the purpose of funding under the STP as "the provision of facilities for pedestrians and bicycles, acquisition of scenic easements and scenic or historic sites, scenic or historic highway programs, landscaping and other scenic beautification, historic preservation, rehabilitation and operation of historic transportation buildings, structures, facilities and canals, preservation of abandoned railway corridors including the conversion and use thereof for pedestrian or bicycle trails. control and removal of outdoor advertising, archaeological planning and research, and mitigation of water pollution due to highway runoff.") Entire project is an enhancement - 15 points Enhancement is a significant component of project - 5 points Enhancement is a minor component of project -2 points
	NEG PTS	**Negative Impacts** of transportation projects on mobility. particularly across modes, was discussed at length, but no consensus on how to measure such impacts, and whether negative impacts were only significant of non-single occupant vehicle projects was reached. This category is included here without quantification to put project sponsors on notice that such negative consequences will be considered, if a methodology can be designed. in future programming cycles.
100		**TOTAL POINTS**

CHAPTER FIVE

IDENTIFICATION AND ASSESSMENT OF CRITERIA USED IN CURRENT PRACTICE

To compare and contrast the criteria used in the evaluations described in these studies, 16 categories were developed from the studies reviewed to determine how a wide range of criteria might be grouped for comparative purposes.

The criteria categories are listed in Table 23, along with typical criteria for each category to help define the categories. These criteria categories identify what appears to be appropriate for the current state of the practice. Modifications may be needed to respond to possible new criteria to support the ISTEA factors identified in Chapter 2.

SUMMARY OF USE OF EVALUATION CRITERIA

Table 24 shows the number of criteria from each evaluation category that each study employed. Table 25 summarizes the information in Table 24 by listing the number of studies that used criteria from each category and the total number of criteria used by category.

Tables 24 and 25 reveal several interesting points:

- Few of the studies employed a wide range of evaluation criteria.
- The regional programming studies considered system coordination and integration much more often than the planning studies.
- The following criteria were left out more often than they were included: mobility, system coordination and integration, land use, freight, energy, safety, cost-effectiveness, equity, financial arrangements, and institutional factors.
- Equity was considered in only one study (conducted under FTA alternative analysis guidelines).
- Few mobility measures were used and no multimodal measures of mobility were identified or used.
- Few studies employed a broad enough range of criteria.

The studies were quite difficult to compare, even within groups, because of several complicating factors, including the following:

- The purpose of the study (some studies merely quickly screened many alternatives; other studies looked carefully at specific technologies in specific corridors)
- Resources available to the study, including both time and funding (these studies obviously ranged greatly)
- Government requirements (such as those under the FTA's alternatives analysis guidelines)
- Stage in the planning process (some studies may have been preliminary feasibility studies; others were serious alternatives analyses that included some engineering component)
- Nature of the planning area (including size of the area, topography, roads available, and the type of development currently in place).

However, in most of the studies, a full range of reasonable criteria that are generally known to the planning profession were *not* used.

Appendix C has detailed criteria tables for each study. These tables reveal that many criteria used to measure the performance and cost of the transportation system may be redundant. Other criteria may measure the same underlying feature and thus exaggerate a project's benefits. For example, extensive use of level-of-service measures in a study that has criteria for addressing travel time may be redundant unless the measures are reduced to some uniform measure.

TABLE 23
CLASSIFICATION OF CRITERIA

General Category	Typical Criteria
1. Transportation System Performance	Number of trips by mode Vehicle miles traveled Congestion Peak hour congestion Transit boardings Highway level of service
2. Mobility	Mobility options Improved movement of people
3. Accessibility	% within 30 minutes, etc. Transit and highway speeds
4. System Development, Coordination and Integration	Terminal transitions Transportation system development Regional importance Projects in existing plans
5. Land Use	Compatibility with land use plans Growth inducement
6. Freight	Reduced goods movement costs
7. Socioeconomic	Homes or businesses displaced Maximize economic benefit Historic impacts Construction employment
8. Environmental	Air quality Sensitive areas Natural environment
9. Energy	Energy consumption
10. Safety	Annual accidents by mode Safety ratings
11. Equity	Equity of benefit and burden
12. Costs	Capital costs Operating costs
13. Cost Effectiveness	Annualized costs per trip or mile FTA (UMTA) index
14. Financial Arrangements	Funds required Funding feasibility — Build/operate Public/private sources
15. Institutional Factors	Ease of staging and expansion Nonimplementing agency support
16. Other	Fatal flaw Right of way opportunities Enforcement Recreation

TABLE 24
COMPARISON OF CRITERIA USED IN EACH CATEGORY BY STUDY

Criteria Category	Intercity Corridor			Regional			HOV Lanes vs. General Purpose	Urban Corridor							Regional Programming			
	San Francisco/ Sacramento	Maryland	Ontario	Honolulu	Toronto	Seattle	Chicago	New Jersey	Raleigh, N.C.	Tappan Zee, N.Y.	Salt Lake City	Marin/ Sonoma	Port-land	Pitts-burgh	Cali-fornia	San Fran-cisco	Denver	Calgary
1. Transportation System Performance	5	6	1	7	3	4	4	3	3	1	5	3	28	7	5	2	2	2
2. Mobility	—	—	—	—	—	1	—	—	—	—	—	—	—	—	—	1	—	1
3. Accessibility	2	2	—	1	—	1	1	1	2	—	2	—	4	4	—	—	—	—
4. System Development, Coordination and Integration	—	1	—	—	—	—	—	2	1	—	—	—	—	—	3	4	5	1
5. Land Use	2	—	—	1	—	4	—	—	—	—	2	—	7	—	1	2	—	1
6. Freight	1	—	—	—	1	—	—	—	—	—	—	—	—	—	1	2	—	—
7. Socioeconomic	1	—	2	4	2	—	1	—	—	—	7	—	7	—	1	—	—	1
8. Environmental	2	—	—	3	1	2	1	1	—	—	7	—	6	—	1	1	—	—
9. Energy	—	—	—	1	—	1	1	—	—	—	1	—	1	—	1	1[1]	—	1
10. Safety	—	1	—	2	—	—	—	—	1	—	—	—	5	—	—	1	1	—
11. Equity	—	—	—	—	—	—	—	—	—	—	1	—	—	—	—	1	—	—
12. Costs	2	2	1	3	2	1	—	—	2	2	3	3	N/A	1	—	1	—	—
13. Cost Effectiveness	—	4	—	2	—	—	—	—	—	—	6	1	N/A	—	5	1	—	—
14. Financial Arrangements	—	—	—	2	—	1	—	—	—	—	2	1	—	—	1	3	—	—
15. Institutional Factors	—	—	—	3	—	—	1	1	—	—	—	—	—	—	—	1	—	—
16. Other	—	2	—	—	—	—	—	2	3	—	—	—	—	—	—	—	3	—

1. MTA's safety measure includes "personal security;" it was the only agency to include this.

TABLE 25
SUMMARY OF USE OF CRITERIA IN STUDIES

Criteria Category	Number of Studies Using Criteria in Category (18 Total)	Summation of All Criteria across All Studies[1]
1. Transportation System Performance	18	91
2. Mobility	3	3
3. Accessibility	10	20
4. System Development, Coordination and Integration	7	17
5. Land Use	8	20
6. Freight	4	5
7. Socioeconomic	9	26
8. Environmental	10	25
9. Energy	8	8
10. Safety	6	11
11. Equity	2	2
12. Costs	12	23
13. Cost Effectiveness	6	19
13. Financial Arrangements	5	10
14. Institutional Factors	4	6
15. Other	4	10

[1]This column is the total of all the criteria used in the 18 studies for each category, and indicates which categories receive the most emphasis.

CHAPTER SIX

CONCLUSIONS

Chapter 2 reviewed federal guidance to assist, and in some cases direct, planners in conducting multimodal evaluations of transportation facilities. The influences of these federal studies can be seen in several of the studies reviewed for this synthesis. Nevertheless, many of the projects reviewed used a greatly abbreviated set of criteria that could not possibly capture all the important information that belongs in an evaluation.

Because the studies reviewed were conducted for different purposes and at various stages in the planning and programming processes, they cannot be easily compared, and it is difficult to criticize any particular study. However, the current state of practice does suggest that additional guidance may be in order. A great help to the industry would be the development of a new document that includes the FTA's alternatives analysis methods (*11*), combined with the US DOT's report written by Sydec (*9*), and that is updated to include new methods and information on calculating inputs. The creation of such a document should be undertaken as quickly as possible because of the requirements of federal, and some state, legislation.

Collectively, the studies employed many useful criteria. One major problem with all of the studies was the lack of a measure of *multimodal mobility*. Typically, comparisons associated highway level of service with transit ridership. Clearly, mobility needs to be defined and measured. Mobility defined as highway level of service does not lead to multimodal solutions.

Based on a collective assessment of the case studies, a measure of mobility might include the following dimensions:

- Access—average of the time by mode necessary to travel to all zones in an area
- Demand—the amount of travel between zones
- Means—a measure of the ability of people to travel
- Choice—a determination of whether or not alternatives exist.

A mobility measure could have other dimensions as well, but the important point is to define the meaning of multimodal mobility and develop methods to measure it.

Meyer, in his 1992 address to the TRB summer planning meeting in Seattle, said, "I would submit that we should not be focusing on a congestion index, but rather a mobility index. If we are truly interested in mobility, then the measure of success of our transportation system should reflect this objective" (*5*).

Although the actual multimodal process was not the focus of this synthesis, it was apparent from some of the documents that a traditional systems analysis method is not always followed; as a result, important steps are left out. Specifically, a clear statement of goals and objectives is not always present, the definition of alternative does not encompass a broad enough range, and methods to measure and model impacts of alternatives are in some cases inadequate.

RECOMMENDATIONS

- New comprehensive guidance is needed at the national level on evaluation methods, criteria, criteria measurements, and impact estimation. The FTA's alternatives analysis document could be a primary basis for this effort.
- A multimodal measure of mobility should be developed to compare effectiveness across modes. This measure should not only reflect mobility implications of highway and transit improvements, but also demand management, land use forms, and nonmotorized travel modes.
- Additional documentation and training at the federal level (to avoid duplication of effort) in multimodal planning could help the profession, which now employs a new generation of planners facing new issues.
- A renewed effort should be made to exchange information about multimodal planning and evaluation. Such an effort could be a joint FHWA, FTA, and TRB committee activity. Continued interchange at the TRB summer planning meetings would be useful and appropriate.

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APPENDIX A

GLOSSARY

ADA—Americans with Disabilities Act

APTA—American Public Transit Association

BTU—British thermal unit

CBD—Central business district

CR—Commuter rail

CRR—Commuter railroad

dB—Decibel

DOT—Department of Transportation

EIS—Environmental impact statement

FEIS—Final environmental impact statement

FHWA—Federal Highway Administration

FTA—Federal Transit Administration

GAO—General Accounting Office

HOV—High-occupancy vehicle

HRT—Heavy rail transit

HSGT—High-speed ground transportation

ISTEA—Intermodal Surface Transportation Efficiency Act

LOS—Level of service (A to F: A is best)

LOV—Low-occupancy vehicle

LRT—Light rail transit

MPO—Metropolitan planning organization

MTC—Metropolitan Transportation Commission

NAAQS—National ambient air quality standards

NSTPS—National Strategic Transportation Planning Study

O&M—Operations and maintenance

PMT—Person mile of travel

SIP—State implementation plan

SOV—Single-occupancy vehicle

SRTP—Short-range transit project

TDM—Travel demand management

TIP—Transportation improvement program

TSM—Transportation systems management

UGB—Urban growth boundary

UMTA—Urban Mass Transportation Administration (now FTA)

US DOT—U.S. Department of Transportation

V/C—Volume to capacity

VHD—Vehicle hour delay

VHT—Vehicle hour of travel

VMT—Vehicle mile traveled

APPENDIX B

NCHRP 20-5 TOPIC 23-04

Synthesis of
MULTIMODAL EVALUATION IN PASSENGER TRANSPORTATION

STATE DOT AND MPO QUESTIONNAIRE

The purpose of this questionnaire is to identify agencies experienced in conducting multimodal evaluations for passenger transportation projects. Typical examples are as follows:

Urban Areas
Light Rail vs. Highway Capacity
HOV Lanes vs. Highway Capacity
HOV vs. Light Rail
Intercity
High Speed Rail vs. Airport Expansion
High Speed Rail vs. Highway Expansion

The NCHRP synthesis will concentrate on 1) the planning and programming process, 2) the analytical procedures used, and 3) the evaluation criteria used in the multimodal evaluation, including urban form and density.

Agency Name: _____

Address: _____

_____

_____

Name of Person Responding: _____

Telephone Number: (_____) _____

1. Has your agency conducted evaluations in which different passenger modes have beeen compared to each other? yes ( ) no ( )

   If yes, please provide a short description of the evaluation or mail a copy of the report that documents the evaluation.

_____

_____

_____

2. Do you know of other agencies that have conducted multimodal evaluations? If yes, please provide a contact.

   Agency: _____

   Name: _____

   Telephone: (_____) _____

3. Who is your agency contact person for additional information? (name and phone)

   Name: _____

   Telephone: (_____) _____

Please mail your response by November 25, 1991, to:

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APPENDIX C

INDIVIDUAL STUDY CRITERIA

Intercity Corridor Studies

1. *Sacramento-San Francisco Intercity Corridor Study*

Table C.1 lists the criteria and measures used for this study. This was one of only four studies that considered freight movement. Six criteria categories were omitted.

2. *Maryland Statewide Commuter Assistance Study*

Maryland employed 5 of the 16 evaluation categories, as shown in Table C.2. The state also considered fatal flaws and right-of-way opportunities.

3. *GO Train Service Expansion Program—Ontario, Canada*

The GO Train study, shown in Table C.3, used few qualitative criteria for evaluation. This study was the most highly aggregated of all the studies.

Regional Studies

4. *HALI 2000, Hawaii*

With the exception of the freight and equity categories, this study (Table C.4) used a full range of evaluation criteria. It was one of only three that considered institutional factors.

5. *Toronto Mobility Study*

This study included five evaluation categories to screen types of transportation improvements for the region. All measures were qualitative, as shown in Table C.5.

6. *Vision 2020 Growth Strategy and Transportation Plan for the Central Puget Sound Region*

This land use/transportation effort included 7 of the 13 evaluation categories. The summary measures shown in Table C.6 were supported by extensive quantitative assessments in earlier work.

7. *Chicago HOV Lane Feasibility Study*

This study used the six criteria categories shown in Table C.7, with qualitative measures to screen HOV facilities. Costs were not included in the evaluation.

Urban Corridor Studies

8. *I-80 New Jersey HOV Lane Feasibility Study*

This study explored the issue of general purpose versus HOV lane additions to I-80. As Table C.8 shows, the criteria were heavily biased toward the implementation and operation of HOV facilities and included such factors as constructability, enforcement, traffic transitions, and queue estimation. Many other traditional measures were not included.

9. *Feasibility of HOV Treatments, I-40, North Carolina*

As in the New Jersey case, the question here was whether to add general purpose or HOV lanes to I-40. Table C.9 shows that again, relatively few criteria categories were used, and the project's emphasis was on operational factors (e.g., enforcement, motorist understanding, and traffic operations).

10. *Tappan Zee Corridor Study—New York*

This study evaluated alternatives to reducing peak hour traffic by using only criteria related to traffic and project costs, as shown in Table C.10. This study employed the fewest categories and criteria.

11. *I-15/State Street Corridor Alternatives Analysis, Salt Lake City*

The criteria for this study are shown in Table C.11. Because this was a cooperative federal, state, and local project and included an environmental impact statement, the criteria list is extensive.

12. *Highway 101 Corridor Plan, Marin/Sonoma Counties, California*

The major issues analyzed in this study were the performance of the transportation system and the costs associated with improving it. Table C.12 shows that three criteria categories and eight criteria provided the basis of evaluation.

13. *Western Bypass Study—Portland, Oregon*

This study included criteria in 8 of the 13 categories and an exhaustive collection of criteria in certain categories (e.g., 28 transportation system performance criteria and 7 land use criteria) (see Table C.13). Treatment of costs was not available in detail when this information was collected. This study had by far the most evaluation criteria (59, compared to 34 for Salt Lake City and 29 for Honolulu).

14. *Parkway West Multimodal Corridor Study, Pittsburgh*

This study evaluated options for facility improvement. It concentrated on system performance and mobility criteria, along with capital costs, as shown in Table C.14. Many traditional evaluation criteria are presumably due in later stages of project development.

Regional Programming Evaluations

15. *Flexible Congestion Relief Program—California Transportation Commission*

The CTC program, summarized in Table C.15, has a well-distributed set of criteria in nine categories. This is one of only four evaluations that considers freight.

16. *Metropolitan Transportation Commission's Programming Process (San Francisco Bay Area)*

The MTC uses a fairly extensive list of criteria to evaluate regional project priorities. Table C.16 lists the criteria.

17. *Denver Regional Council of Governments' Highway Transit Program and Process*

The Denver method, used only for interstate substitution projects, is interesting because of its heavy concentration on system coordination and integration. It also has several special criteria that give transit projects a slight advantage. Table C.17 lists Denver's criteria.

18. *Transportation Improvement Priority Study, Calgary, Canada*

Calgary, as seen in Table C.18, uses seven criteria in six categories for regional programming. Each criterion is weighted and assigned a score so that each project receives an overall score for ranking purposes.

SUMMARY

These tables and narrative show that there is little agreement within the profession on the evaluation criteria that should be used. Projects that are related to, or influenced by, federal procedures tend to use traditional criteria more extensively.

Table C.1. Intercity Corridor Criteria — San Francisco/Sacramento Study

General Category	Criteria	Measures[1]
1. Transportation System Performance	Daily commute trips	Trips by mode and transit share[2]
	Daily vehicle miles traveled	VMT[2]
	Level of service (PM peak hr) for sections of I-80	LOS[2]
	Vehicle hours of delay (PM peak hr)	VHD[2]
	Lane-miles of congestion (PM peak hr)	Lane-miles by arterials and freeways[2]
2. Mobility	—	—
3. Accessibility	Comparative travel time (PM peak hr) for selected segments (I-80 and transit)	Time decrease[2]
	Regional accessibility: special generator and key travel movements	Description[3]
4. System Development, Coordination and Integration	—	—
5. Land Use	Compatibility with local/regional land use plans	
	Potential for growth inducement	
6. Freight	Facilitates urban goods movement	Assessment[3]
7. Socioeconomic	Potential for displacements of homes or businesses	
8. Environmental	Air quality	Reduction in VMT and VHD[2]
	Sensitive areas	Identification[3]
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	Capital costs	Costs by mode[2]
	Operating costs	Costs by mode[2]
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]Measures compared to year 2015 Base Case
[2]Quantitative measures
[3]Qualitative measures

Table C.2. Intercity Corridor Criteria — Maryland Statewide Commuter Assistance Study

General Category	Criteria	Measures
1. Transportation System Performance	Screenline V/C ratio	V/C ratio[1]
	% Highway lane mileage log	% LOS A, B, C, D, E, F[1]
	Person miles traveled (AM peak hr)	Miles by LOV, HOV, transit[1]
	Transit boarding (AM peak hr)	Boardings by mode[2]
	% commuter miles operation at LOS D or better	% of miles by mode[1]
	Vehicle miles traveled (AM peak hr) change from null alternative	Change in VMT[1]
2. Mobility	—	—
3. Accesibility	Travel times to selected locations	Travel time by mode[1]
	Enhancement of access to existing or planned areas of economic development	Low, moderate, high[2]
4. System Development, Coordination and Integration	Compatibility with local transportation plans	Yes, no[2]
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	—	—
9. Energy	—	—
10. Safety	Other issues including safety	—
11. Equity	—	—
12. Costs	Capital cost	Cost by mode[1]
	Annual operating cost	Cost by mode[1]
13. Cost Effectiveness	Annualized cost per trip served — transit only	Cost per transit trip[1]
	Annualized cost per trip mile served — all modes	Cost per mile[1]
	Ability to meet 50% cost/revenue ratio	Yes/no[1]
	FTA (UMTA) cost effectiveness index	(Not used)[1]
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	Fatal flaw evaluation	OK/not OK[2]
	Right of way opportunities	Name R.O.W.[2]

Note: [1]Quantitative measures
[2]Qualitative measures

Table C.3. Intercity Corridor Criteria — GO Train, Toronto

General Category	Criteria	Measures
1. Transportation System Performance	Provide reasonable level of service	Note[1]
2. Mobility	—	—
3. Accessibility	—	—
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	Maximize potential economic benefits	Note[1]
	Acceptable level of social and economic impacts	
8. Environmental	—	—
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	Acceptable implementation costs	Note[1]
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]Each project ranked as follows:

- Acceptable performance
- Unacceptable performance
- Probably will occur anyway

Table C.4. Regional Criteria — Hali 2000 Regional Study, Honolulu

General Category	Criteria	Measures
1. Transportation System Performance	Weekday resident trips by mode	Number of trips[1]
	Work trips by public transit	%[1]
	Peak hour resident trips to major destinations on public transit	%[1]
	Person trips on public transit by major screenlines	%[1]
	Weekday vehicle travel by: Hours of delay Travel on congested roadways	 Hours[1] %[1]
	Peak hour traffic to design capacity	Ratio[1]
	Downtown parking spaces	Change in spaces[1]
2. Mobility	—	—
3. Accessibility	Significant reduction in travel time to major employment centers	List of areas[2]
4. System Development, Coordination and Integration	—	—
5. Land Use	Reinforcement of area development plans	Minimal to encourage[2]
6. Freight	—	—
7. Socioeconomic	Land acquisition	Acres[1]
	Parkland impacts	Minimal to major[2]
	Historical/cultural impacts	Minimal to major[2]
	Project construction employment	Number of jobs[1]
8. Environmental	Daily emissions	Tons by type[1]
	Visual impacts	Miles evaluated[1]
	Ecosystem (wildlife and endangered plant species)	Possible areas[2]
9. Energy	Energy consumption	Billions of BTU's
10. Safety	Travel safety (all modes) Annual accidents Annual injuries	 Numbers[1] Numbers[1]
11. Equity	—	—
12. Costs	Capital costs by mode	$[1]
	Operating costs by mode	$[1]
	Equivalent annual cost	$[1]
13. Cost Effectiveness	Public transit annualized capital and operating cost per passenger	$/pass.[1]
	Public transit operating cost per passenger	$/pass.[1]
14. Financial Arrangements	Capital needs by source	$[1]
	Operating needs by source	$[1]
15. Institutional Factors	Impact on military installations	Type[2]
	Ease of staging	Poor to excellent[2]
	Ease of expansion	Poor to excellent[2]
16. Other	—	—

Notes: 1) Quantitative criteria
2) Qualitative criteria

Table C.5. Regional Criteria — Generic Opportunities for Toronto

General Category	Criteria[1]	Measures[2]
1. Transportation System Performance	Passenger capacity increase and traffic flow improvement	0 1 2 3
	Choice increase	
	Demand reduction	
2. Mobility	—	—
3. Accessibility	—	—
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	Reduced goods movement costs	0 1 2 3
7. Socioeconomic	Public acceptance	0 1 2 3
	Economic impact	
8. Environmental	Emissions control	0 1 2 3
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	Capital cost	0 1 2 3
	Operating cost	
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]These criteria were used to screen potential courses of action and were not applied to specific projects or corridors.

[2]The measures were as follows:

0 = Unfavorable
1 = Neutral
2 = Favorable
3 = Highly Favorable

Table C.6. Regional Criteria — Vision 2020, Seattle Area

General Category	Criteria	Measures
		Better ● ◑ Worse[2] ○
1. Transportation System Performance	Transit/ridesharing	
	Delay and congestion	
	Demand management potential	
	Vehicle travel	
2. Mobility	Mobility options available	● ◑ ○
3. Accessibility	Level of public service	● ◑ ○
4. System Development, Coordination and Integration	—	—
5. Land Use	Open space	● ◑ ○
	Job housing balance	
	Redistributes growth to areas with available services	
	People-oriented urban design more likely	
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	Environmentally sensitive areas	● ◑ ○
	Air quality	
9. Energy	Energy consumption	● ◑ ○
10. Safety	—	—
11. Equity	—	—
12. Costs	Overall cost	● ◑ ○
13. Cost Effectiveness	—	—
14. Financial Arrangements	Funding difficulties	● ◑ ○
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]These criteria were selected from more detailed studies to appear in the FEIS for the study.

[2]All criteria were evaluated on a three point scale.

Table C.7. Regional Criteria — HOV Corridor Screening Guidelines Chicago Area

General Category	Criteria	Measures
1. Transportation System Performance	Congestion	Note[1]
	Demand	
	Capacity improvement	
	Transit impact	
2. Mobility	—	—
3. Accessibility	Travel time savings	Note[1]
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	Public policy support[2]	Note[1]
8. Environmental	Air quality[3]	Note[1]
9. Energy	Energy[3]	Note[1]
10. Safety	—	—
11. Equity	—	—
12. Costs	—	—
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	Non-implementing agency support[2]	Note[1]
16. Other	—	—

Notes: [1]Measures for all criteria were:

Advantage
Neutral
Disadvantage

[2]These two criteria were combined.

[3]These two criteria were combined.

Table C.8. Urban Corridor Criteria — I-80 HOV Lane Feasibility Study, New Jersey (HOV vs. General Purpose Lanes)

General Category	Criteria	Measures
1. Transportation System Performance	Demand analyses 1995, 2000	Traffic volumes in all lanes[1]
	Queue lengths	Miles[1]
	Occupancy	2+ occupancy vehicles[1]
2. Mobility	—	—
3. Accessibility	Travel time savings for HOV lane users	Minutes[1]
4. System Development, Coordination and Integration	Transitions at termini	Engineering assessment[2]
	Intermediate ingress/egress movements	Engineering assessment[2]
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	HOV lane air quality benefits	VMT reductions[1] Speed differentials[1]
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	—	—
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	Marketing/constituency building	Surveys and assessments[2]
16. Other	Constructability	Engineering assessment[2]
	Enforcement provisions	Engineering assessment[2]

Note: [1]Quantitative criteria
[2]Qualitative criteria

Table C.9. Urban Corridor Criteria — Feasibility of HOV Treatments on I-40, Raleigh, N. C., Area

General Category	Criteria	Measures
1. Transportation System Performance	Travel demand (1987 and 2008)	Peak hour volumes[1]
	Vehicle occupancy	Base year occupancies[1]
	Directional distribution	East-west split[1]
2. Mobility	—	—
3. Accessibility	Travel speed (1987 and 2008)	MPH[1]
	Travel time between key points	Minutes[1]
4. System Development, Coordination and Integration	Traffic operations	Engineering assessment[2]
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	—	—
9. Energy	—	—
10. Safety	Safety	Engineering assessment[2]
11. Equity	—	—
12. Costs	Costs	
	Construction	$[1]
	Enforcement	$/yr[1]
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	Enforcement	Engineering assessment[2]
	Motorist understanding	Engineering assessment[2]
	New York warrants[3]	Engineering assessment[1,2]

Note: [1]Quantitative criteria

[2]Qualitative criteria

[3]Boyle, Daniel K., Proposed Warrants for High Occupancy Vehicle Treatments in New York State, Transportation Analysis Report 54, June 1985.

Table C.10. Urban Corridor Criteria — Tappan Zee Bridge Corridor Study

Criteria Category	Criteria	Measures
1. Transportation System Performance	Travel impact	Peak hour traffic[1]
2. Mobility	—	—
3. Accessibility	—	—
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	—	—
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	Estimated cost	$[1]
13. Cost Effectiveness	—	—
14. Financial Arrangements	Cost effectiveness of impacts on peak hour traffic	1
15. Institutional Factors	—	—
16. Other	—	—

[1]Quantitative criteria

Table C.11. Urban Corridor Criteria — I-15/State Street Corridor, Salt Lake City Area

General Category	Criteria	Measures
1. Transportation System Performance	Utilization by mode	Trips by mode[1] Mode split[1]
	Level of service at selected locations	Volumes[1] V/C ratio[1] Level of service[1] Speed[1]
	Level of service: VMT per day on congested roads Total miles of congested roads Key intersections	 Thousands of miles[1] Miles[1] L.O.S.[1]
2. Mobility	—	—
3. Accessibility	Auto travel times (selected)	Minutes[1]
	Transit travel times (selected)	Minutes[1]
4. System Development, Coordination and Integration	—	—
5. Land Use	Conformity to land use plans	Narrative[2]
	Joint development potential	Identify sites[2]
6. Freight	—	—
7. Socioeconomic	Displaced businesses/residences	Number displaced[1]
	Economics and development	Narration[2]
	Employment impact	Jobs — short and long term
	Net fiscal impact	$ for construction and operations
	Parklands impact	Name of parks displaced[1]
	Cultural resources/historic sites	Number displaced
	Construction	Narrative[2]
8. Environmental	Natural environment: Geologic hazards Natural resources/water Quality/vegetation/wild life Soils and agriculture Wetlands Air quality Noise	 Identify[2] Narrative[2] Acres of farmland removed[1,2] Acres of wetland removed[1] Narrative[1,2] Number of sites impacted[2]
9. Energy	Energy	Barrels of oil saved and travel cost[1]
10. Safety	—	—
11. Equity	Equity of benefit and burden	Narrative[2]
12. Costs	Total capital costs	$[1]
	Annual O & M costs	$
	Total annualized cost	$
13. Cost Effectiveness	Annual time savings to transit riders	$
	Annual time savings to HOV users	$
	Annual time savings to highway users	$
	FTA (UMTA) indices	$/new rider
	Capital cost-effectiveness	$/rider
	O & M cost-effectiveness	$/rider
14. Financial Arrangements	Source of revenue for O& M	Cash flow
	Source of revenue for capital	Cash flow
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]Quantitative criteria
[2]Qualitative criteria

Table C.12. Urban Corridor Criteria — Highway 101 Corridor Marin/Sonoma County, California

General Category	Criteria	Measures
1. Transportation System Performance	Level of service by segment	A - F[1]
	Severe congestion	Miles @ LOS F[1]
	Transit ridership	Number of riders[1] by mode, daily and peak hour
2. Mobility	—	—
3. Accessibility	—	—
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	—	—
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	Capital costs (total and annualized)	$ costs by mode[1]
	Transit operating costs	$ total and net[1]
	Total annual costs	$ by mode[1]
13. Cost Effectiveness	Transit cost effectiveness	Annualized capital costs/passenger mile[1] Net operating cost/passenger mile[1] Total cost/passenger mile[1]
14. Financial Arrangements	Total funds required over 20 years	$
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]All criteria are quantitative.

Table C.13. Urban Corridor Criteria — Western Bypass Study, Portland Area

General Category	Criteria	Measures
1. Transportation System Performance	Reduce traffic congestion	
	• Improvement in level of service over no-build by facility	3 point scale[2]
	• PM peak-hour vehicle hours of delay	VHD[1]
	• Change in VHD vs. no-build	%[1]
	• PM peak-hour vehicle hours of travel	VHT
	• Change in VHT vs. no-build	%
	• Relative congestion reduction rating	3 point scale[2]
	Through-traffic diversion	
	• North-south arterial capacity	3 point scale[2]
	• PM peak-hour vehicle miles of travel by facility group	VMT[1]
	• Change in VMT vs. no-build	%[1]
	• Relative through-traffic diversion reduction rating	3 point scale[2]
	Reduce reliance on single occupant vehicles	
	• Total study area average weekday person trips	Number of trips[1]
	• Total work person trips by mode	Number of trips[1]
	• Growth in work person trips by mode relative to no-build	%[1]
	• Work trips by modal share	%[1]
	• Relative reduction in SOV dependency (work trips)	3 point scale[2]
	• Same criteria for non-work trips as work	
	• Total study area vehicle trips	Number of trips[1]
	• Change in vehicle use over no-build	%[1]
	• Average study area vehicle occupancy	Occupancy[1]
	• Percent of study area population within 1/4 mile of transit route	%[1]
	• Potential to spread peak-hour traffic	3 point scale[2]
	• Relative reduction in SOV dependency (all trips)	3 point scale[2]
	Provide flexibility for future needs	
	• Ability to increase capacity of facility over time	3 point scale[2]
	• Ability to adapt to changing travel conditions or modes	3 point scale[2]

Note: In addition to the above evaluation matrix, a descriptive matrix, using the same criteria, was developed that verbally compares trade-offs between the alternatives.

[1]Quantitative criteria

[2]Qualitative criteria

Table C.13. Urban Corridor Criteria — Western Bypass Study, Portland Area (Continued)

General Category	Criteria	Measures
2. Mobility	—	—
3. Accessibility	• Percent of study area within 30 minutes of 800,000 population	%[1]
	• Percent of study area within 30 minutes of 500,000 jobs	%[1]
	• Percent of study area within 15 minutes of 25,000 retail jobs	%[1]
	• Relative accessibility rating	3 point scale[2]
4. System Development, Coordination and Integration	—	—
5. Land Use	Supports efficient urban development patterns	
	• Provides for efficient delivery of urban services	3 point scale[2]
	• Consistency with existing local plans	3 point scale[2]
	• Consistency with state and regional plans	3 point scale[2]
	Pressure on urban growth boundary (UGB)	
	• Location of improvements relative to fringe of UGB	3 point scale[2]
	• Ability to mitigate potential negative impacts	3 point scale[2]
	• Proximity of improvements to vacant urban land	3 point scale[2]
	• Proximity of improvements to vacant urbanizable land	3 point scale[2]
6. Freight	—	—
7. Socioeconomic	Long term impacts on built environment	
	• Acquisition of land	3 point scale[2]
	• Impacts on public facilities/services	3 point scale[2]
	Neighborhood/business community disruption	
	• Relative displacement of residences and businesses	3 point scale[2]
	• Relative rural displacement	3 point scale[2]
	Economic health of study area[3]	
	• Relative study area employment accessibility	3 point scale[2]
	• Relative study area residence accessibility	3 point scale[2]
	• Relative study area retail accessibility	3 point scale[2]

Note: In addition to the above evaluation matrix, a descriptive matrix, using the same criteria, was developed that verbally compares trade-offs between the alternatives.

[1]Quantitative criteria

[2]Qualitative criteria

[3]These measures are similar to those listed under Accessibility Criteria (#2).

Table C.13. Urban Corridor Criteria — Western Bypass Study, Portland Area (Continued)

General Category	Criteria	Measures
8. Environmental	Long term effects on natural environment	
	• Hydrology/water quality impacts	3 point scale[2]
	• Ecosystems/wetlands impacts	3 point scale[2]
	• Air quality impacts	3 point scale[2]
	• Agricultural and forest land impacts	3 point scale[2]
	• Visual resource impacts	3 point scale[2]
	• Geological resource impacts	3 point scale[2]
9. Energy	Energy impacts[4]	
10. Safety	Safety	
	• Relative congestion reduction rating	3 point scale[2]
	• Relative through-traffic diversion Reduction rating	3 point scale[2]
	• Potential conflicts between different modes of travel	3 point scale[2]
	• Disruption of pedestrian/bicycle circulation patterns	3 point scale[2]
	• Relative safety rating	3 point scale[2]
11. Equity	—	—
12. Costs	N/A[5]	N/A
13. Cost Effectiveness	N/A	N/A
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	—	—

Note: In addition to the above evaluation matrix, a descriptive matrix, using the same criteria, was developed that verbally compares trade-offs between the alternatives.

[1]Quantitative criteria

[2]Qualitative criteria

[3]These measures are similar to those listed under Accessibility Criteria (#2).

[4]Energy impacts were included under Environmental Criteria (#7).

[5]Not complete at time of report.

Table C.14. Urban Corridor Criteria — Parkway West Multi-Modal Corridor Study, Pittsburgh Area

General Category	Criteria	Measures
1. Transportation System Performance	Level of service • Deficient lane miles • Rating	 Miles[1] 0 to 5[2]
	Average daily volumes at key locations	ADV[1]
	Ridership • System wide • Facility	 Riders[1] Riders[1]
	Daily vehicle miles traveled	VMT[1]
	Daily vehicle hours traveled	VHT[1]
2. Mobility	—	—
3. Accessibility	Highway speed • Average speed • Rating	 MPH[1] 0 to 5[2]
	Transit Speed • Average speed • Rating	 MPH[1] 0 to 5[2]
4. System Development, Coordination and Integration	—	—
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental	—	—
9. Energy	—	—
10. Safety	—	—
11. Equity	—	—
12. Costs	Capital Costs	$
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]Quantitative criteria
[2]Qualitative criteria

Table C.15. Programming Criteria — California Transportation Commission's Flexible Congestion Relief

General Category	Criteria[3]	Measures
1. Transportation System Performance	Existing congestion problem	Duration of LOS E[1] Peak hour volumes (people or vehicles)[1] Vehicle volume to capacity ratio[1] Rail transit peak hour load factor[1]
	Estimated level of service	Estimated future (within 10 years) peak hour level of service or rail transit load factor[1]
2. Mobility	—	—
3. Accessibility	—	—
4. System Development, Coordination and Integration	Modal integration	Assessment of degree of integration with alternative modes[2]
	System linkage	Integration with larger system, compatibility with adjacent projects[2]
	Trip generators	Service to major generators[2]
5. Land Use	Community[4]	Degree to which project fits into community plans[2]
6. Freight	Freight Movement	Degree to which freight traffic is expedited and/or congestion reduced[2]
7. Socioeconomic	Community[4]	Degree to which project is accepted by community[2]
8. Environmental	Environmental[4]	Relative benefit of project vs. environmental impacts
9. Energy	Energy[4]	Energy efficiency of constructing and operating project
10. Safety	—	—
11. Equity	—	—
12. Costs	—	—
13. Cost Effectiveness	Cost effectiveness of investment	R.O.W plus construction costs to provide additional hourly vehicle capacity[1]
		R.O.W plus construction costs to provide additional trips per hour[1]
	Time savings index	Reduced travel time vs. total project costs (capital plus O & M)[1]
	Marginal cost for peak hour improvement	R.O.W. plus construction costs per additional peak hour person trips (within 10 years)[1]
14. Financial Arrangements	Local financial participation	Amount of local and private financial contributions[1]
15. Institutional Factors	—	—
16. Other	—	—

Note: [1]These are quantitative measures.

[2]These are qualitative measures.

[3]Quantitative criteria are rank ordered for evaluation as follows:

1) Existing congestion
2) Cost effectiveness
3) Time savings index
4) Local financial participation
5) Marginal cost
6) Estimated level of service

[4]These are considered as one criteria in the evaluation.

Table C.16. Regional Programming Criteria — Metropolitan Transportation Commission (San Francisco Area)

General Category	Criteria	Highway Measures	Transit Measures
1. Transportation System Performance	Congestion reduction[1]	Impact on highway capacity	Impact on highway capacity
	Project merit[1]	Shift away from SOV	Quality and efficiency
2. Mobility	Regional importance	Improved movement of people	—
3. Accessibility	—	—	—
4. System Development, Coordination and Integration	Regional importance	Contribution to system continuity	Contribution to system continuity
	Projects included in short-term regional plan	Commitment to a prior transportation plan	Commitment to a prior transportation plan
	Project included in long-term regional plan	Contribution to regional transportation systems	Contribution to regional transportation systems
5. Land Use	—	—	—
6. Freight	Regional importance	Improved movement of goods	—
7. Socioeconomic	—	—	—
8. Environmental	Pollution control reasures[3]	Contribution toward implementing traffic control measures	Contribution toward implementing traffic control measures
9. Energy	—	—	—
10. Safety	Project merit	Safety impact	
11. Equity	—	—	—
12. Costs	Project merit	—	Rate of return
13. Cost Effectiveness	Project merit	—	Rate of return
14. Financial Arrangements	Degree of federal, state and local financial support[2]	Amount of federal, state and local financial support	Amount of federal, state and local financial support
15. Institutional Factors	—	—	—
16. Other	—	—	—

Note: [1]Criteria for Congestion Reduction, Regional Importance and Project Merit are assigned a "User Benefit" score from 0 - 20.

[2]Criteria for Degree of Financial Support and Projects Included in Short- and Long-Term Regional Plans are assigned a "Regional Priority" score from 0 -20.

[3]The criteria for Pollution Control Measures is assigned an "Air Quality" score from 0 -20.

Table C.17. Regional Programming Criteria — Denver Regional Council of Governments

General Category	Criteria	Measures
1. Transportation System Performance	Highest or lowest number of daily commute trips	+1 or -1
	Highest or lowest system capacity	+1 or -1
2. Mobility	—	—
3. Accessibility	—	—
4. System Development, Coordination and Integration	Project is/is not in regional plan	+1 or -1
	Project is/is not in local plan supporting the regional plan	+1 or -1
	Project is recommended in a related transportation study	+1 or -1
	Project is/is not coordinated with other communities	+1, 0, -1
	Project includes/does not include transit design features	+1 or -1
5. Land Use	—	—
6. Freight	—	—
7. Socioeconomic	—	—
8. Environmental[1]	—	—
9. Energy	—	—
10. Safety	Highest/lowest roadway safety	+1 or -1
11. Equity	—	—
12. Costs	—	—
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	Project includes/does not include a deficient bridge	+1 or 0
	Project provides/does not provide for HOV capacity in addition to transit capacity	+1 or -1
	Project includes/does not include special provisions for elderly, handicapped and minority individuals	+1 or 0

Note: Projects were assumed to further regional air quality goals by encouraging higher occupancies and decreasing vehicle miles traveled.

Table C.18. Regional Programming Criteria — Calgary

General Category	Criteria	Measures
1. Transportation System Performance	Best use of transportation modes	Score
	System efficiency	Score
2. Mobility	Mobility	Score
3. Accessibility	—	—
4. System Development, Coordination and Integration	Transportation system development	Score
5. Land Use	Land use and transportation system compatibility	Score
6. Freight	—	—
7. Socioeconomic	Environmental quality	Score
8. Environmental	—	—
9. Energy	—	—
10. Safety	Safety	Score
11. Equity	—	—
12. Costs	—	—
13. Cost Effectiveness	—	—
14. Financial Arrangements	—	—
15. Institutional Factors	—	—
16. Other	—	—

Notes: Scores are assigned to each project from 1 to 29 (best to worse project).
Criteria were weighted to provide an overall project score.

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