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Socioeconomic and Travel Forecasts for Alternatives Analysis in the Puget Sound Region

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ABSTRACT

The development and use of socioeconomic and travel forecasts for evaluation of major transit investments in the Puget Sound region of Washington State are described. Although procedures used to produce socioeconomic and travel forecasts may be considered standard relative to techniques used elsewhere, the analysis and interpretation of the results have had a substantial impact on the decisions of policy makers in the region. How the results are being used for decision making is the thrust of this paper. Highlighted is how forecasts have been used at each phase of the transportation planning process: for systems planning, for corridor analysis, and for project planning. First, forecasts played a key role in defining the nature of the future regional transportation system as contained in the Regional Transportation Plan. Predictions of levels of highway congestion and potential transit ridership were subsequently used to rank corridors as to priority for further analysis. In evaluating alternative transit projects within corridors, policy makers have given priority to those projected to generate additional transit patronage. Because billion-dollar decisions are being made today for tomorrow's transit capital and operating programs, the need for constant update of the regional data base and forecasting capabilities has been reinforced. Additional survey work and model refinements are planned to help ensure that adequate technical information is available as projects go into preliminary engineering.

In 1982 the Puget Sound Council of Governments (PSCOG) adopted a new Regional Transportation Plan (1). The plan constituted a major departure from earlier plans in that it contained an explicitly stated policy that there would be no new freeway corridors or major highway expansion in the region during the next 20 years. Yet the adopted population and employment forecasts used in preparing the plan implied that an almost 45 percent increase in daily person trips in the region would occur between 1980 and 2000. To help accommodate this growth in travel demand, the elected officials set as objectives of the plan to increase the market share of transit and of ridesharing over the next 20 years. These objectives were to be met through the development and implementation of aggressive transit and ridesharing programs.

Figure 1 shows the location of the Puget Sound region, which includes the cities of Everett, Seattle, and Tacoma. (The arrow indicates the corridor currently under study.) Population and transportation characteristics for the region are summarized in Table 1. As indicated in Table 1, use of transit for the work trip is forecast to increase from 9.6 percent to 11.7 percent during the 20-year period on a regional basis. Daily average vehicle occupancy is expected to increase from 1.38 in 1980 to 1.46 in 2000. Although this still is less than the average vehicle occupancy in 1960, a reversal of the downward trend that occurred between 1960 and 1980 is an objective of the plan. Figures 2 and 3 are graphs of transit use and average vehicle occupancy during the period 1960-2000.

Although a transit mode split for work trips of 11.7 percent in 2000 is forecast for the region as a whole, the proportion using transit for work trips destined for downtown Seattle is expected to increase from 40 percent in 1980 to 54 percent in 2000. In Table 2 downtown Seattle population, employment, and travel data are compared for 1980 and 2000. Given the large increases in employment projected for downtown Seattle and the high levels of transit use for trips to the central business district (CBD), the need for a higher-capacity transit system, such as light rail, seemed likely. PSCOG decided that the feasibility of a light rail transit

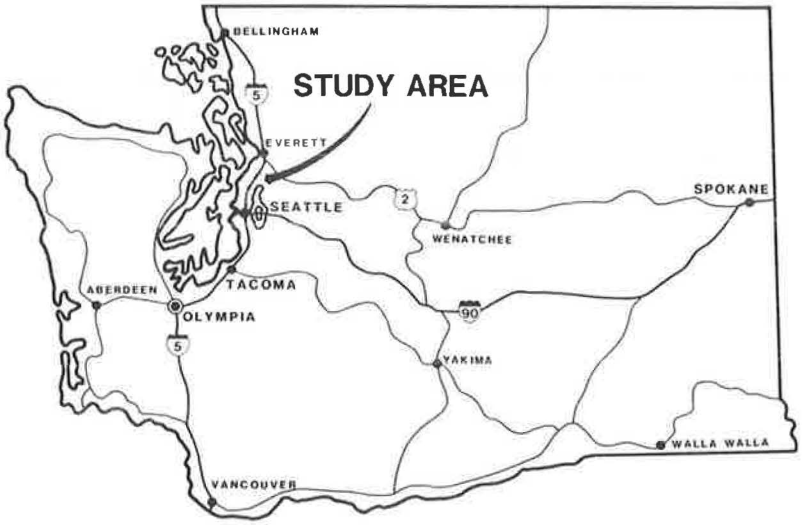

FIGURE 1 Location of Puget Sound region.

TABLE 1 Central Puget Sound Region: Population and Transportation Characteristics

	YEAR		
DATA ITEM	1960	1980	2000
Population	1,366,200	2,102,500	2,920,900
Transit Trips (Daily)	161,300	246,900	412,200
Percent total trips	5.2%	3.9%	4.6%
Percent work trips	9.5%	9.6%	11.7%
Vehicle Trips (Daily)	2,155,000	4,468,000	6,324,600
Average vehicle occupancy	1.54	1.38	1.46
Average trip length (miles)	5.90	7.73	7.98
Vehicle miles of travel	12,715,000	34,538,000	50,500,000
Per Capita Measures			
Transit trips	.12	.12	.14
Vehicle trips	1.58	2.13	2.17
Vehicle miles of travel	9.30	16.43	17.29

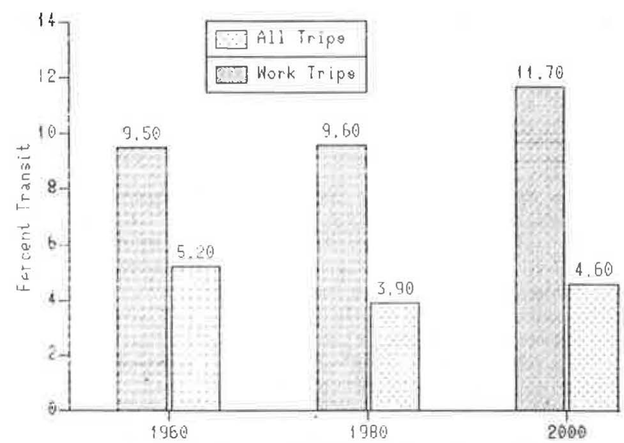

FIGURE 2 Percentage of daily trips by transit, Puget Sound region.

(LRT) system for Seattle should be assessed as part of the development of the Regional Transportation Plan. An outside consultant was asked to evaluate the potential for LRT in Seattle by 2000. The transit forecasts used for this assessment were those developed for the Regional Transportation Plan based on an all-bus system. In this preliminary study it was concluded that the transit demand in 2000 in at least two of the major travel corridors (the North Corridor and the East Corridor) would be well above the apparent decision threshold of 4,000 to 7,000 passengers per peak hour used by policy bodies in other cities choosing light rail and that this mode would be cost effective in Seattle (2). In fact, in the North Corridor, transit demand has already exceeded this threshold level; the evening peak-hour peak-direction transit demand was 7,000 in 1980.

On the basis of this study and as a result of the emphasis that the elected officials felt must be

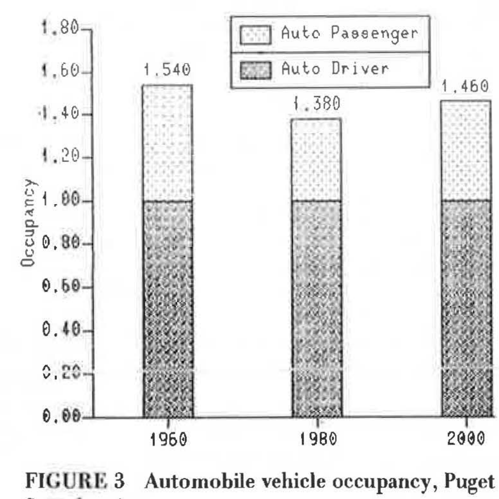

FIGURE 3 Automobile vehicle occupancy, Puget Sound region.

placed on transit development during the next 20 years, PSCOG and the Municipality of Metropolitan Seattle (METRO) decided to jointly evaluate alternative transit investments in major corridors.

TABLE 2 Downtown Seattle: Population, Employment, and Transportation Characteristics

	YEAR	
DATA ITEM	1980	2000
Population	10,730	20,400
Employment	114,900	179,100
WORK TRIPS (DAILY) No. of Trips	175,400	265,200
Percent Transit	39.9%	53.6%
No. of Transit Trips	69,900	142,200
NON-WORK TRIPS (DAILY) No. of Trips	293,000	397,900
Percent Transit	14.5%	16.2%
No. of Transit Trips	42,400	64,600

RANKING CORRIDORS BY PRIORITY FOR ANALYSIS

In keeping with the guidelines laid out by UMTA for alternatives analysis (3), only one corridor could be evaluated at a time. Projected population and employment growth and travel forecasts were used to rank the major corridors by priority for analysis (4). These data are summarized in Table 3 for the North, East, South, and Eastside Corridors. The transit ridership estimates shown are based on an all-bus system.

The two most heavily traveled corridors today are the North and the East Corridors. Although a larger percentage of growth in population and employment was forecast for the East Corridor than for the North Corridor, the projected absolute number of transit riders was predicted to be considerably higher for the North Corridor.

TABLE 3 Central Puget Sound Region: Population, Employment, and Peak-Hour Transit Ridership for Major Travel Corridors

	CORRIDOR			
DATA ITEM	NORTH[a]	EAST	SOUTH[a]	EASTSIDE
CORRIDOR POPULATION				
1980	441.0	227.0	187.0	236.0
2000	544.0	331.0	275.0	405.0
Percent Growth	23.4%	45.8%	47.0%	71.6%
CORRIDOR EMPLOYMENT				
1980	241.0	181.0	316.0	138.0
2000	357.0	308.0	446.0	239.0
Percent Growth	48.1%	70.2%	41.1%	73.2%
PEAK-HOUR RIDERSHIP				
1980	7.1	3.5	2.2	0.4
2000	14.0	8.7	4.6	0.7
Percent Growth	97%	149%	109%	75%

Note: Data are in thousands.
[a]Includes population and employment in the Seattle CBD.

Analysis of future vehicle trip demand for each of the corridors also revealed that the most severe congestion was likely to occur in the North Corridor. Figures 4 and 5 indicate the levels of congestion in the North Corridor in 1980 and 2000, respectively. In 1980, heavy congestion occurred along several segments of I-5 and adjacent arterials, whereas in 2000 severe congestion is forecast on both I-5 and Aurora Avenue (State Route 99).

Figures 6, 7, and 8 show what is likely to occur on I-5 and Aurora at 145th Street. In Figure 6 the existing distribution of traffic volumes in the afternoon and evening hours at 145th Street is represented. The reference line represents the capacity across this screen line. The peak period today is from approximately 4:00 p.m. to 6:00 p.m. In Figure 7 traffic volumes in 2000 are indicated. Given the same distribution of traffic over time as today, demand would well exceed capacity during today's 2-hr peak period. Figure 8 shows what might happen if all the traffic demand that has been forecast is to be accommodated: More than a 4-hr period of severe congestion would occur. Of course, other things might happen--trips might redistribute themselves or not occur at all. However, forecasts for the North Corridor indicate that an extension of today's peak-hour congestion is extremely likely.

On the basis of this analysis, the steering committee for the study (made up of elected officials from King and Snohomish Counties and a representative from the Washington State Department of Transportation) selected the North Corridor as the corridor with the highest priority for consideration of major transit improvements. The corridor stretches from downtown Seattle to south Snohomish County. Figure 9 shows the rankings for all corridors.

DEVELOPMENT AND SCREENING OF ALTERNATIVES FOR THE NORTH CORRIDOR

Following the selection of the North Corridor as the priority corridor for analysis, alternative alignments and transit technologies were evaluated. Several different technologies and up to eight different alignments were initially considered for the North Corridor. The technologies considered included conventional bus, advanced-technology bus (dual-propulsion vehicles that may or may not run on a guideway), LRT, and exclusive guideway. Figure 10 shows the initial set of alignments. On the basis of existing transit volumes and practical engineering considerations, these were quickly reduced to three alignments: I-5, Aurora Avenue (State Route 99), and a crossover alignment that used parts of each of these two major facilities.

The steering committee also chose at this time to eliminate consideration of exclusive guideway as a separate technology. Their decision was based on the following reasoning. First, preliminary transit forecasts did not appear to justify consideration of heavy rail as an alternative for the Seattle metropolitan region. Second, light rail operating on I-5 would essentially operate on an exclusive right-of-way for much of its length, and engineering considerations for light rail on this alignment would not be unlike those for heavy rail if the latter should come under consideration in the future.

Light rail and conventional bus were thus the technologies considered for each of these alignments, whereas the advanced-technology bus was considered only for I-5. The six basic alternatives endorsed by the steering committee for study included the following:

1. No build,
2. Transportation systems management (TSM),

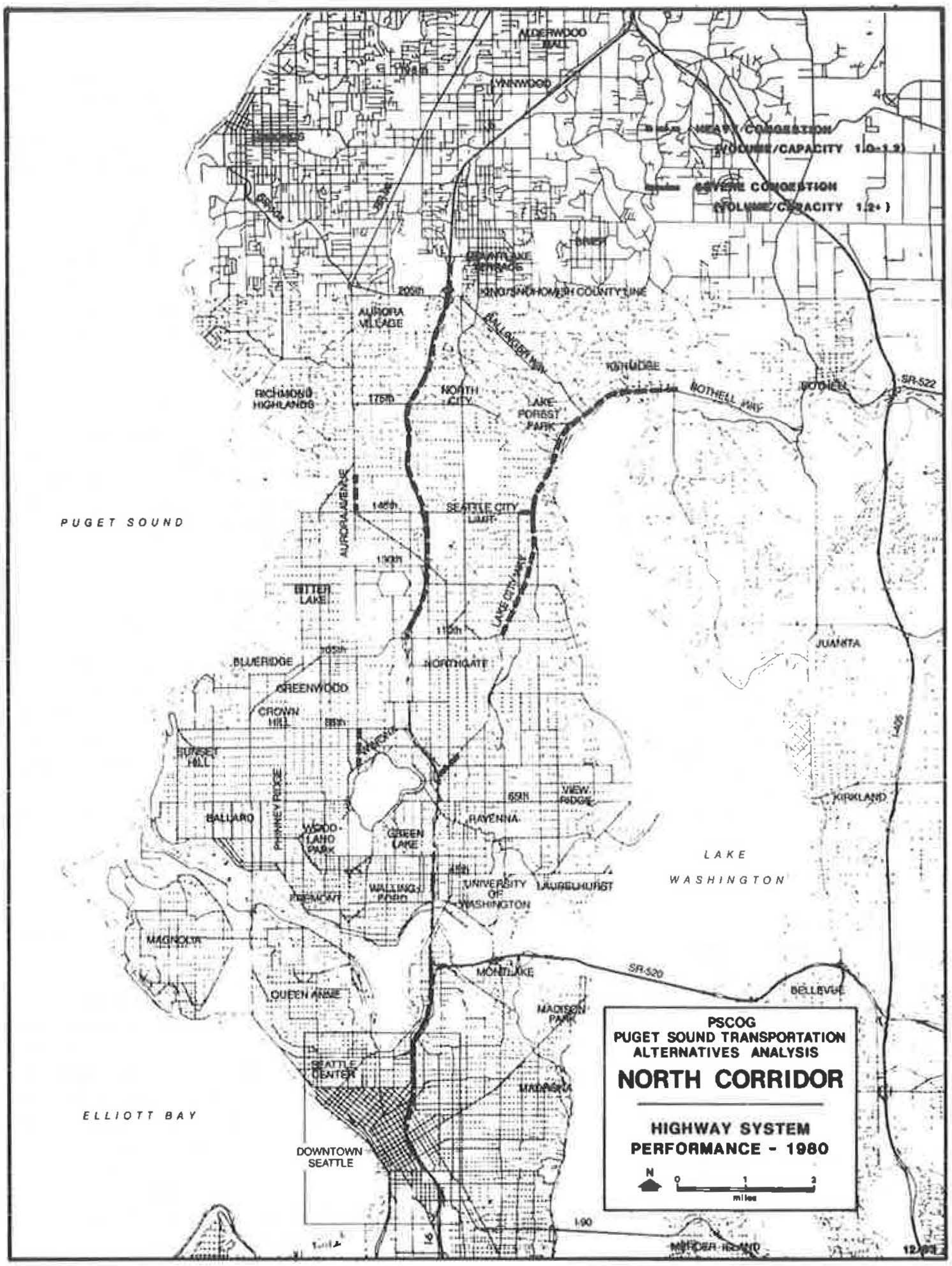

FIGURE 4 Highway system performance, 1980.

3. I-5 guided busway,
4. I-5 LRT,
5. Aurora/I-5 LRT, or
6. Aurora LRT.

Although there were six basic alternatives for the North Corridor, preliminary travel forecasts were prepared for more than 12 different variations. The 12 variations reflected the different combinations of alignments with technologies, surface, and subsurface options in downtown Seattle and different lengths for the light rail and guided-busway options. Figure 11 shows the 12 variations for which preliminary forecasts were prepared.

For the purpose of travel forecasting--and in keeping with UMTA guidelines for alternatives analysis--there were a number of technical and policy assumptions that were held the same for all alternatives. These included the following:

1. Population and employment forecasts (as adopted by PSCOG in 1982);
2. Trip generation by purpose;
3. Highway system (as adopted in the Regional Transportation Plan with exceptions as noted in the following);
4. Trip distribution;
5. Mode-split model coefficients;
6. Transfer penalties;
7. Highway operating costs, future parking costs, and transit fares; and
8. Level of service and geographic coverage of the North Corridor feeder-bus networks.

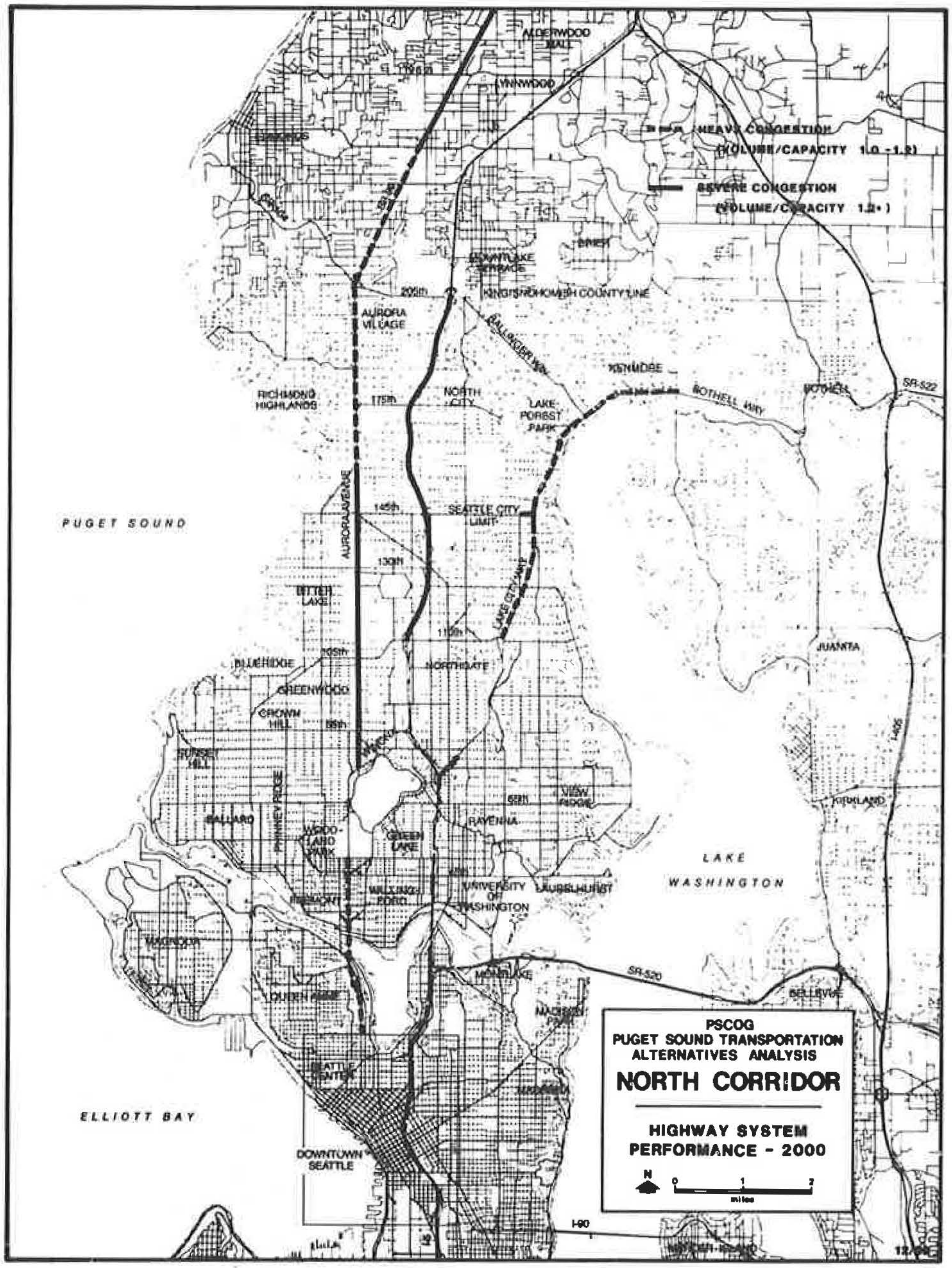

FIGURE 5 Highway system performance, 2000.

The assumptions that varied by alternative primarily affected the coding of the transit networks and included the following:

1. Alignment for the line-haul system,
2. Station locations,
3. Top operating speeds and average speeds in the CBD,
4. CBD stop times,
5. Park-and-ride lot locations,
6. Feeder-bus transfer points, and
7. Coded highway networks to reflect the taking of lanes for transit or the implementation of high-occupancy-vehicle facilities for the all-bus or TSM alternative.

Preliminary forecasts for the 12 variations were prepared over a 3-month period in spring 1983. The peak-hour peak-direction volumes on the line-haul system for the Aurora and Aurora/I-5 crossover alternatives ranged from 2,900 to 5,900, respectively, whereas the peak-hour peak-direction volumes on the I-5 line-haul facility (for either light rail or advanced-technology bus) were estimated at 9,000 to 10,200 passengers. These preliminary forecasts were presented to the steering committee in August 1983. The committee recommended that on the basis of these forecasts, the remaining work should focus on the I-5 alternatives only.

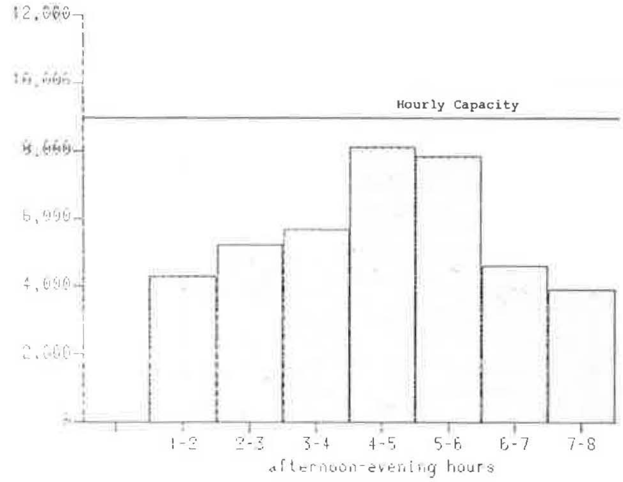

FIGURE 6 Existing traffic volumes, northbound I-5 and Aurora at 145th Street.

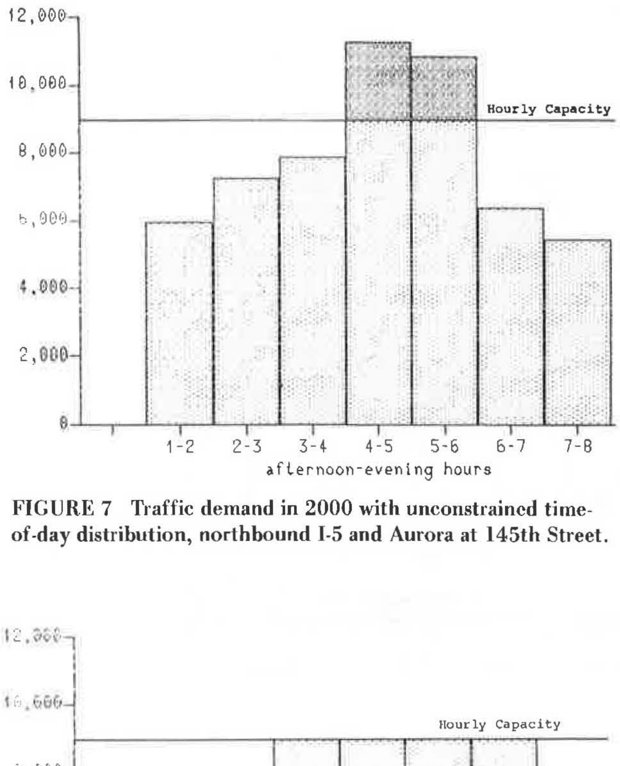

FIGURE 7 Traffic demand in 2000 with unconstrained time-of-day distribution, northbound I-5 and Aurora at 145th Street.

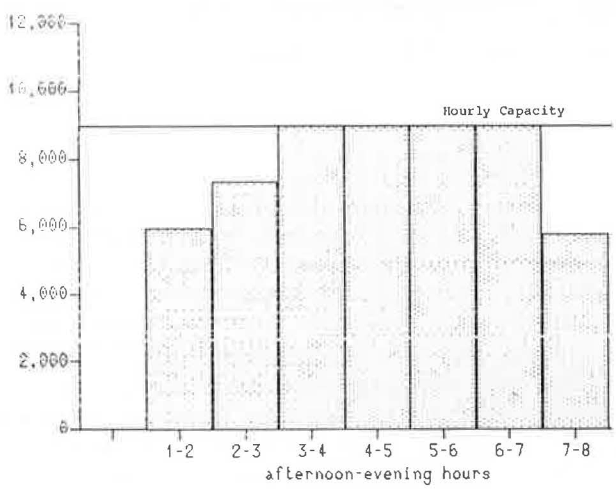

FIGURE 8 Traffic volumes in 2000 with peak spreading, northbound I-5 and Aurora at 145th Street.

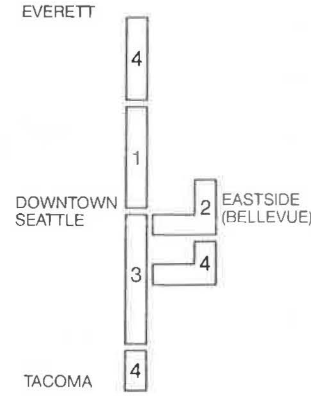

FIGURE 9 Corridor ranking.

REFINEMENT OF PATRONAGE FORECASTS FOR I-5 ALTERNATIVES

Additional refinement and analysis were carried out for five major alternatives on the I-5 alignment. These alternatives included

1. No build,
2. TSM,
3. Advanced-technology bus,
4. LRT in downtown tunnel, or
5. LRT on downtown mall.

Figure 12 shows the I-5 alignment for the LRT alternative. The advanced-technology bus would run on the surface out in the corridor and operate on a guideway in a tunnel in downtown Seattle. The buses would have dual-propulsion capabilities, using diesel power outside the CBD and running under electric power in the tunnel.

For the I-5 LRT alternatives, two lengths were evaluated. The maximum length would extend to Alderwood Mall in south Snohomish County, whereas the minimum length would end at 145th Street at the Seattle city limits. Refinements to the coded networks were made to reflect the final definition of alternatives. Coded speeds for the express line-haul transit service were adjusted to reflect an analysis of peak and off-peak speeds based on demand to capacity relationships on I-5 and at interchanges.

Table 4 summarizes existing and projected transit ridership for each of the alternatives. Both daily and annual figures are provided for the North Corridor and for the region as a whole. North Corridor transit trips are defined as those having at least one end of the trip within the North Corridor. As indicated in Table 4, the maximum-length LRT alternative operating in a tunnel in downtown Seattle would have the largest ridership, which would be 33,000 more daily trips than the no-build condition in 2000. The alternative with the next highest patronage estimate is the maximum-length surface LRT; there would be a difference of 29,000 trips daily relative to the no-build condition. The advanced-technology bus and the minimum-length LRT in a downtown tunnel produce only slightly different levels of transit patronage--27,000 and 26,000 more trips than those under the no-build condition, respectively.

The percentage of daily person trips in the North Corridor using transit in 2000 for each alternative is provided in Table 5. For trips to downtown

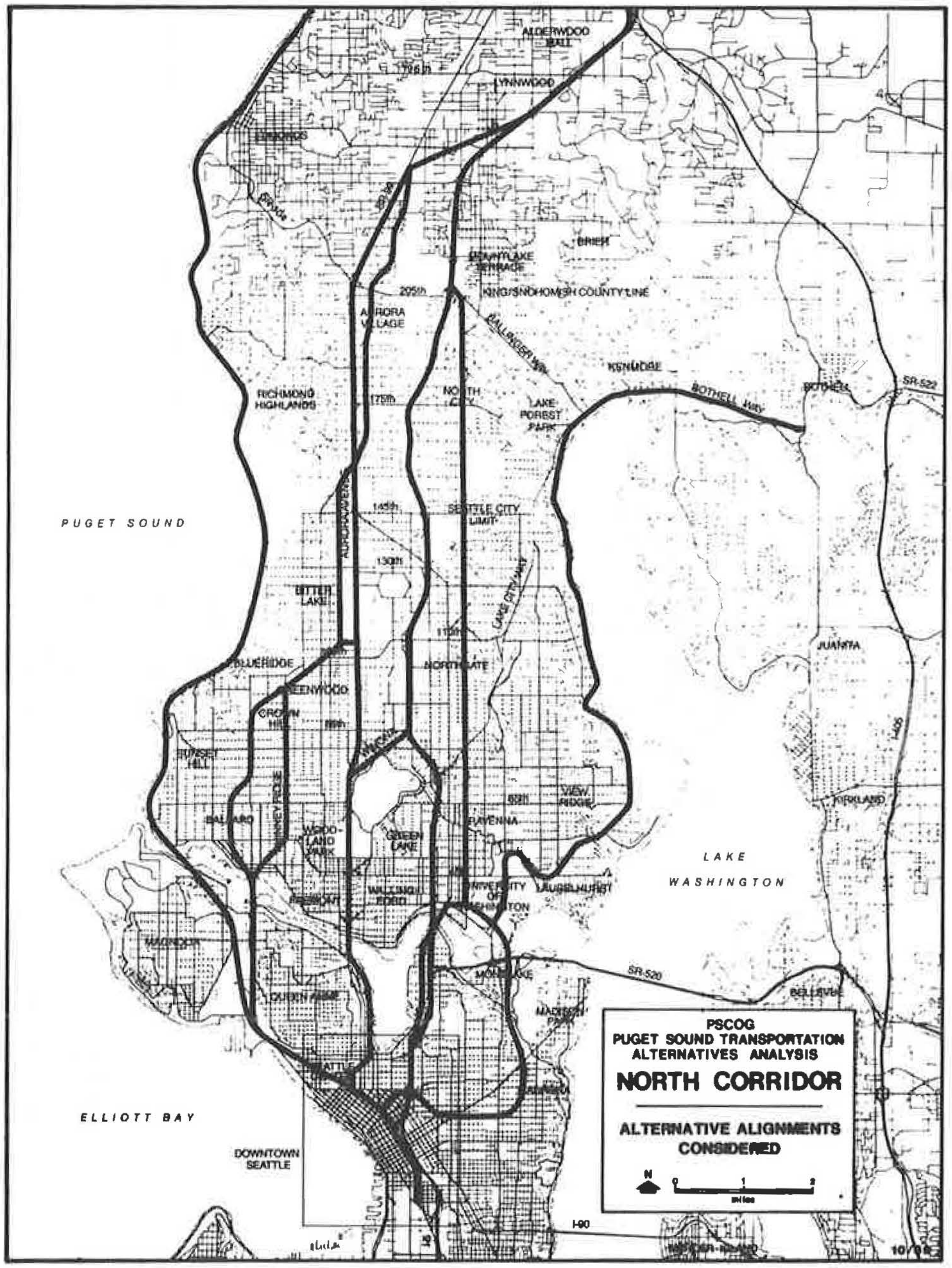

FIGURE 10 Alternative alignments considered.

Seattle, the percentage using transit ranges from 39.8 to 41.9 for the light rail alternatives. The advanced-technology bus captures 41.3 percent of the trips, and 40.8 percent of the trips are expected to use transit if the TSM alternative is implemented. Figure 13 is a graph showing the mode choice to the Seattle CBD on a daily basis. The build alternatives all increase the transit trips while they reduce the automobile trips relative to the no-build condition; the LRT alternative effects the greatest shift from automobile to transit.

In Figure 14 off-peak and peak-hour ridership are compared by alternative. The 4-hr peak shown combines the projected morning and afternoon ridership. One of the major differences between the LRT alternative and the advanced-technology bus alternative is demonstrated in Figure 14. The LRT alternative is a two-way operation throughout the day, improving the level of service not only for the commute to work but for midday trips as well. Trips to the University District would benefit from this service as would trips to south Snohomish County where employment is increasing rapidly. The advanced-technology bus uses the express lanes on I-5 inbound in the morning and outbound in the evening; although it improves operating speeds in downtown Seattle, it does not improve service in the off-peak direction.

EFFECT OF ALTERNATIVES ON VEHICULAR TRAFFIC VOLUMES

Tables 6 and 7 give daily and peak-hour traffic demand at selected locations in the North Corridor. Table 6 includes daily traffic volumes on all high-

	Alignment			Technology		Downtown		Length	
	I-5	I-5/A	AURORA	GB	LRT	SURFACE	TUNNEL	MAXIMUM	MINIMUM
1	●			●			●		●
2	●			●			●	●	
3	●				●		●		●
4	●				●		●	●	
5	●				●	●			●
6	●				●	●		●	
7		●			●		●		●
8		●			●		●	●	
9		●			●	●			●
10		●			●			●	
11			●		●	●			●
12			●		●			●	

FIGURE 11 Major investment alternatives considered.

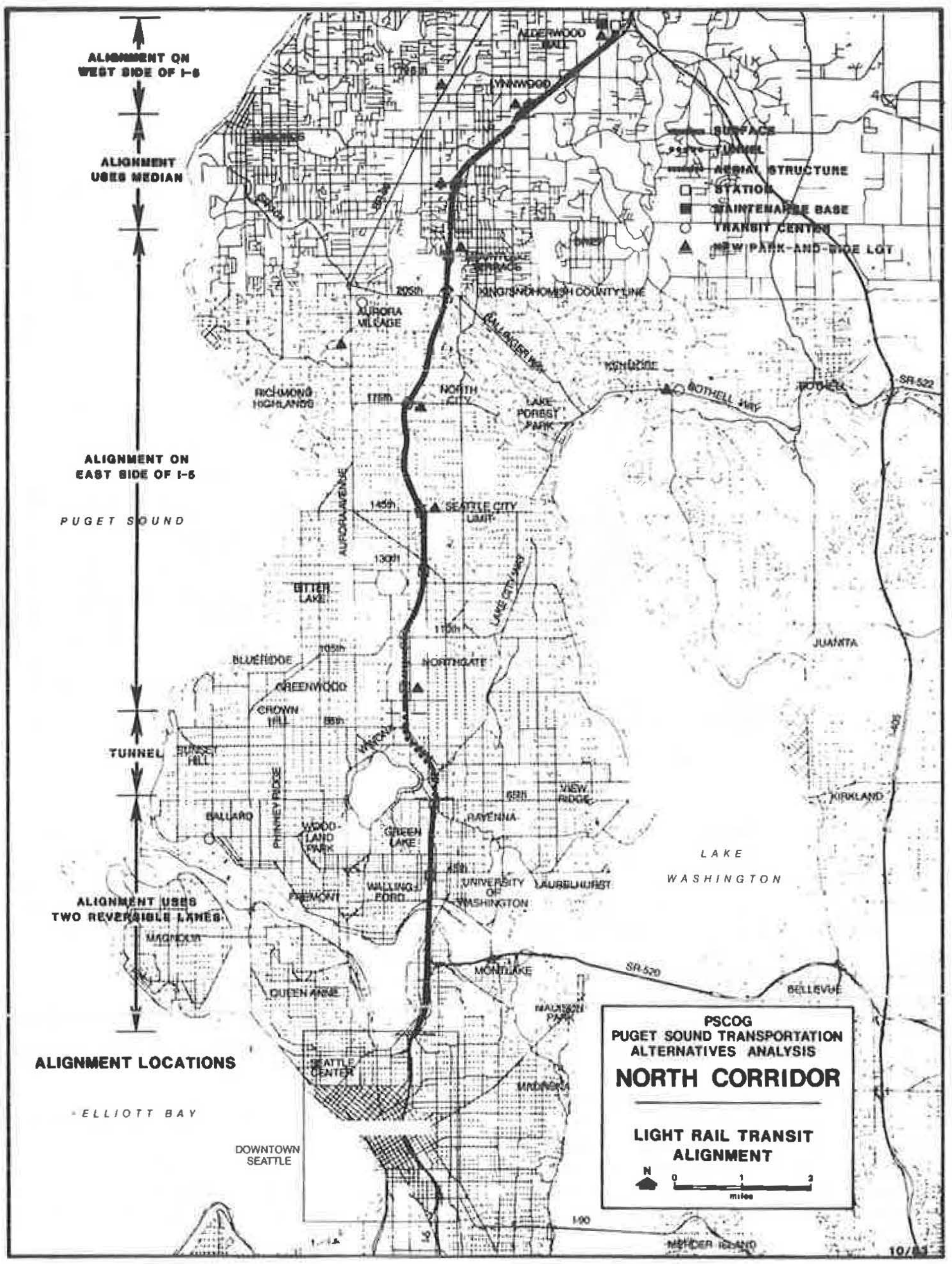

FIGURE 12 LRT alignment.

TABLE 4 North Corridor Alternatives Analysis: Transit Ridership in 1980 and 2000

AREA	EXISTING (1980)	YEAR 2000 NO-BUILD	TSM	A.T. BUS	I-5 LRT IN TUNNEL MIN.	IN TUNNEL MAX.	ON MALL SURFACE MIN.	ON MALL SURFACE MAX.
NORTH CORRIDOR								
Daily	142	215	234	242	241	248	238	244
Annual	44,700	67,700	73,700	76,200	75,900	78,100	75,000	76,900
Growth	NA	+52%	+65%	+71%	+70%	+75%	+68%	+72%
REGION								
Daily	210	325	352	360	359	366	356	362
Annual	66,100	102,400	110,900	113,400	113,100	115,300	112,100	114,000
Growth	NA	+55%	+68%	+72%	+71%	+74%	+70%	+73%

Note: Data are in thousands.

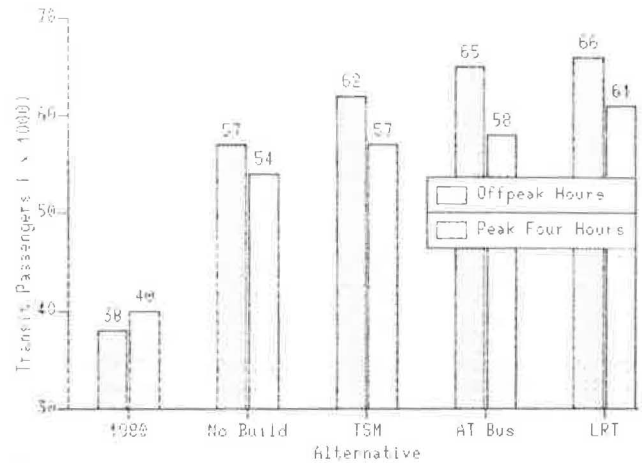

FIGURE 14 North Corridor transit volumes at ship canal screen line, 2000.

TABLE 5 North Corridor Alternatives Analysis: Percentage of Daily Person Trips on Transit in 2000

AREA	NO-BUILD	TSM	A.T. BUS	LRT DOWNTOWN TUNNEL MIN.	DOWNTOWN TUNNEL MAX.	DOWNTOWN SURFACE MIN.	DOWNTOWN SURFACE MAX.
NORTH CORRIDOR							
To Downtown	37.6%	40.8%	41.3%	40.2%	41.9%	39.8%	41.5%
Total	7.3%	8.2%	8.3%	8.5%	8.5%	8.4%	8.4%
REGION							
To Downtown	35.0%	37.9%	38.4%	37.9%	38.7%	37.7%	38.5%
Total	4.2%	4.5%	4.6%	4.6%	4.7%	4.6%	4.6%

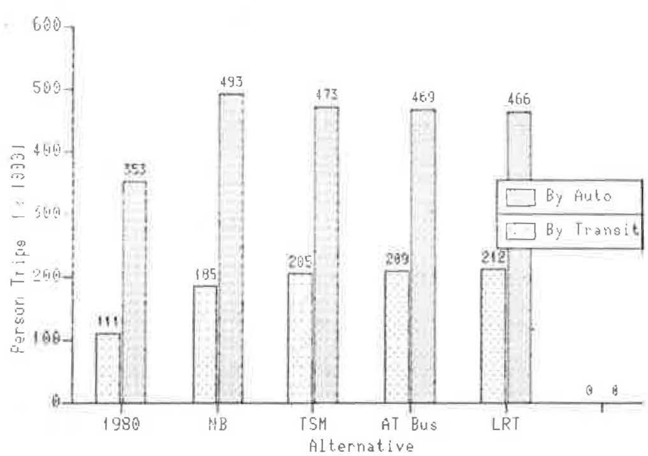

FIGURE 13 CBD mode choice, daily person trips in 2000.

ways and arterials across the ship-canal and 145th Street screen lines. Screen line 35 is at the ship canal, and screen line 41 is at 145th Street. At the ship canal, the advanced-technology bus and the TSM alternative are both expected to reduce traffic volumes from 432,000 (no-build condition) to 421,000 vehicles. A reduction to 418,000 vehicles is projected for the LRT alternative. Similar reductions

TABLE 6 North Corridor Alternatives Analysis: Daily Traffic Demand

SCREENLINE LOCATION	EXISTING	YEAR 2000 NO-BUILD	TSM	A.T. BUS	LRT TUNNEL	LRT SURFACE
Ship Canal	358	432	421	421	418	418
North of 145th	242	320	316	316	315	315

Note: Data are in thousands of vehicles.

TABLE 7 North Corridor Alternative Analysis: Peak-Hour Traffic Demand

SCREENLINE LOCATION		EXISTING	YEAR 2000 NO-BUILD	TSM	A.T. BUS	LRT TUNNEL	LRT SURFACE
Ship Canal	Volume	16	19	18	18	17	17
	Capacity	20	20	20	20	20	20
North of 145th[a]	Volume	8	11	11	11	10	10
	Capacity	9	9	9	9	9	9

Note: Data are in thousands of vehicles. Includes traffic on I-5 and Aurora Avenue only.
[a]Does not include the volume of capacity of diamond lanes reserved exclusively for transit or carpools.

in traffic volumes are forecast for the 145th Street screen line. Reductions in traffic at 145th Street are critical in 2000, because there are few alternative routes and congestion at this location causes severe bottlenecks throughout the corridor.

As indicated in Table 7, the TSM and advanced-technology bus alternatives are expected to remove 1,000 vehicles from peak-hour traffic crossing the ship canal on I-5 and Aurora, whereas 2,000 vehicles can be expected to be eliminated by the LRT alternative. Although the build alternatives do not eliminate traffic congestion during the peak period, they provide some relief. North of 145th Street on I-5 and Aurora Avenue, only the LRT alternative seems to eliminate a measurable number of vehicles from the road.

USE OF FORECASTS FOR DECISION MAKING

The patronage estimates and traffic impacts for each alternative are currently being reviewed by the steering committee, and during the coming months a preferred alternative will be selected. The steering committee has identified as the most important evaluation criterion the ability to maximize transit ridership in 2000 and afterwards. The ability to reduce traffic congestion ranks fourth. (The second- and third-ranked criteria were the ability to gain public support and the ability to expand the system into other corridors.) The committee members are studying the results of the travel forecasting process carefully and asking for tests of sensitivity of the forecasts to policy variables under their control. Additional analysis and refinement of the forecasts are likely to occur throughout the development of the draft environmental impact statement for the project.

The steering committee has requested information on patronage estimates for systems other than Seattle. Table 8 gives a summary of such information. The cities selected for inclusion in the table are those with light or heavy rail under study or development. Among the 10 cities, Seattle ranks second in percentage using transit to work, according to the 1980 census. (Among all U.S. cities with more than 1 million population, Seattle ranks 21st in population but 12th in percentage using transit for the journey to work.) Although it is difficult to determine whether the patronage estimates are directly comparable to one another, this survey of other studies indicates that peak-hour peak-direction volumes as well as daily volumes forecast for a major transit investment in Seattle's North Corridor equal or surpass those of other cities.

FUTURE TRAVEL FORECASTING EFFORTS IN SEATTLE

The North Corridor alternatives analysis has reinforced the need for constant review and update of the Puget Sound regional transportation data base and travel forecasting capabilities. Billion-dollar decisions are being made today concerning transit capital and operating programs for the next 20 years. The magnitude of these investments has brought policy-maker support for additional survey work and enhancements of the modeling process that should ensure the availability of adequate technical information as projects go into preliminary engineering.

ACKNOWLEDGMENT

Material presented in this paper is drawn from studies funded in part by grants from UMTA and FHWA administered through the Washington State Department of Transportation. The authors would like to thank Robert Shindler of PSCOG for his comments and suggestions.

TABLE 8 Comparison of Transit Patronage for Selected Cities

	1980 STATISTICS(a)			PATRONAGE FORECASTS(b)				
URBANIZED AREA(c)	POPULATION (millions)	% TRANSIT TO WORK	TRANSIT RIDERSHIP(d) (millions)	MODE UNDER STUDY OR DEVELOPMENT	FORECAST YEAR	CORRIDOR	PEAK-HOUR PEAK DIR.(e)	DAILY VOLUME(e)
Baltimore	1.91	10.6	114.8	Heavy Rail	1995	North/Metro Center	9,200	85,000
Seattle	1.38	10.1	85.0	Light Rail/ Guided Bus	2000	North	10,800	88,000
Portland	1.08	8.4	48.5	Light Rail	1990	Banfield Westside	6,400 6,300	47,800 53,100
Atlanta	1.62	7.4	99.0	Heavy Rail	1980 (Actual)	East Line	8,100	N.A.(f)
Denver	1.50	6.9	55.0	Light Rail	1990	West	8,700	50,000
Buffalo	1.06	6.6	37.0	Light Rail	2000	Amherst	8,200	68,000
Miami	1.61	6.4	76.6	Heavy Rail	2000	Systemwide	N.A.(f)	181,000
San Jose	1.25	3.2	31.7	Light Rail	1990	Guadalupe	7,800	40,000
San Diego	1.76	3.1	36.5	Light Rail	1995	"Tijuana Trolley"	1,600	45,000
Houston	2.61	2.8	42.8	Heavy Rail	1995	Westpark	12,000	141,900

(a) Sources: 1980 Census (5); APTA Transit System Operating Statistics Report (6).
(b) Sources: Draft Environmental Impact Statements; project staff.
(c) In order of percent transit to work.
(d) Unlinked passenger trips; all modes combined.
(e) At maximum load point.
(f) Not available.

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Predicting Travel Volumes for High-Occupancy-Vehicle Strategies: A Quick-Response Approach

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ABSTRACT

The development of a set of demand and supply models that predict peak-hour travel volumes for high-occupancy-vehicle (HOV) strategies on freeways is described. The demand models were estimated by using a consistent series of before-and-after empirical data from a number of actual HOV facilities located across the United States. Supply models were developed on the basis of speed-volume relationships that estimate changes in running speeds and travel times on the general-purpose lanes for different volume levels and capacity configurations. These models have been incorporated into a set of easy-to-use worksheets to predict equilibrium travel flows of vehicles on the general-purpose freeway lanes and of carpools and buses on the HOV lane or lanes. The models forecast the net change in volume due to mode shift, time of day, trip generation, and route diversion behavior. Consequently, the models provide more information on anticipated travel impacts than can be obtained by using mode-choice models alone. Because the forecasting procedure is designed to provide quick-response results, data requirements are minimal and these data should be readily available to most planning agencies. The accuracy of the forecasting procedure should be interpreted as sketch-planning-level responses that, if conditions warranted, would be subjected to additional and possibly more refined analyses. However, test applications of the prediction procedures described yielded favorable results. Using only data collected before HOV facilities were established, average errors across the HOV sites were less than 4 percent for the nonpriority automobile and HOV bus modes and less than 14 percent for the priority automobile and carpool mode.

Priority treatments for high-occupancy vehicles (HOVs) are transportation system improvements that have proved to be highly cost-effective solutions to meeting urban transportation needs in selected cities across the United States. Given current constraints on constructing new highways in urban areas, such low-capital projects as HOV facilities could become even more popular during the next decade. Although there currently exist computerized models such as the Urban Transportation Planning System (UTPS) that can be used to forecast the travel impacts of alternative HOV treatments, there has historically been little development of approaches that can be used expressly for evaluating HOV strategies in a quick-response time frame.

In this paper the development and testing of a travel forecasting procedure designed specifically for predicting travel volumes resulting from the implementation of priority treatments for HOVs on freeways are described. The procedures developed and described in this paper are intended to be implementable in the face of severe constraints on turnaround time, data availability, and computational resources, while at the same time providing information that is both accurate and easy to obtain. To meet this quick-response capability, forecasts of peak-hour volumes (i.e., for nonpriority automobiles, carpools, and bus transit) can be made by using an ordinary hand-held calculator and a set of worksheets that contain the demand, supply, and equilibrium procedures that were developed.

A comprehensive review of current forecasting procedures revealed that no existing travel demand models have been estimated using actual before-and-after data from the broad cross section of HOV dem-