Technical Report Documentation Page

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-97/1356-6		

4. Title and Subtitle APPLICATION OF FULL-COST OF URBAN PASSENGER TRANSPORTATION CASE STUDY: SAN ANTONIO NORTHEAST (IH-35) CORRIDOR	5. Report Date September 1996 6. Performing Organization Code
7. Author(s) Jiefeng Qin, Michael T. Martello, José Weissmann, and Mark A. Euritt	8. Performing Organization Report No. Research Report 1356-6
9. Performing Organization Name and Address Center for Transportation Research The University of Texas at Austin 3208 Red River, Suite 200 Austin, Texas 78705-2650	10. Work Unit No. (TRAIS) 11. Contract or Grant No. Research Study 0-1356
12. Sponsoring Agency Name and Address Texas Department of Transportation Research and Technology Transfer Office P. O. Box 5080 Austin, Texas 78763-5080	13. Type of Report and Period Covered Interim 14. Sponsoring Agency Code

15. Supplementary Notes

Study conducted in cooperation with the U.S. Department of Transportation, Federal Highway Administration.
Research study title: "Development of an Urban Transportation Investment Model"

16. Abstract

Using a full-cost approach, we evaluated the different transportation improvement alternatives (developed by Rust Lichliter/Jameson) available for the Northeast (IH-35) corridor in San Antonio, Texas. Through MODECOST — a computer model based on the full-cost analysis concept — we found that the current facility cannot meet future traffic demands. As a result, travelers on this facility will continue to bear substantial external costs, including congestion and air pollution costs. The results clearly show that, to meet future demand, the San Antonio/Bexar County Metropolitan Planning Organization will need to expand the current facility from downtown San Antonio to Loop 1604. As our investigation revealed, the savings that will accrue from the reduction of external costs and users costs exceed the cost of initial investment.

Indeed, the case study described in this report shows that, in many cases, external costs and user costs are more relevant than the initial investment in the facility. Expanding the current facility to add HOV lanes to accommodate ride-sharing and special transit service can reduce the external costs and user costs, which in turn, reduce the full cost of the facility.

The study also shows that full-cost analysis is an effective tool for valuing transportation investment alternative comparisons — and one capable of enhancing qualitative assessments and planning/engineering judgment. The actual value calculated by the full-cost analysis sometimes can be used as an assessment indicator to policy-makers and transportation professionals.

17. Key Words	18. Distribution Statement
MODECOST, full cost, facility cost, user cost, external cost, agency cost, San Antonio, Texas	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161.

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	56	

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APPLICATION OF FULL COST OF URBAN PASSENGER TRANSPORTATION
CASE STUDY: SAN ANTONIO NORTHEAST (IH-35) CORRIDOR

by

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Research Report Number 1356-6

Research Project 0-1356

Development of an Urban Transportation Investment Model

conducted for the

Texas Department of Transportation

in cooperation with the

U.S. Department of Transportation
Federal Highway Administration

by the

CENTER FOR TRANSPORTATION RESEARCH

Bureau of Engineering Research

THE UNIVERSITY OF TEXAS AT AUSTIN

September 1996

IMPLEMENTATION RECOMMENDATIONS

This report, which describes one of the five case studies assessing the full cost of urban passenger transportation alternatives, evaluates the different transportation improvement alternatives available for the Northeast (IH-35) corridor in San Antonio, Texas. Given its effectiveness for valuing transportation investment alternative comparisons, full-cost analysis represents a critical element in developing a multimodal transportation investment plan. In terms of implementation, the findings in this report demonstrate that full-cost analysis is capable of enhancing qualitative assessments and planning/engineering judgment.

Prepared in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration.

REPORTS FOR THIS PROJECT

1356-1, "Full-Cost Analysis of Urban Passenger Transportation," by Jiefeng Qin, Karen M. Smith, Michael T. Martello, Mark A. Euritt, and José Weissmann. This report examines methods for evaluating and comparing urban passenger transportation projects regardless of mode. After identifying the full-cost approach as an effective tool for undertaking such comparisons, this report describes MODECOST, a full-cost evaluation model developed by the Center for Transportation Research (CTR) of The University of Texas at Austin.

1356-2, "Development of a Multimodal Full-Cost Model — MODECOST," by Jiefeng Qin, José Weissmann, Michael T. Martello, and Mark A. Euritt. This report summarizes the development of MODECOST, a multimodal full-cost model. First, various cost categories for three modes of a passenger transportation system — auto, bus, and light rail — are identified. This is followed by a discussion of procedures used for annualizing the life-cycle costs of each component of a transportation system. The report also summarizes the unit cost data found in the literature and data received from officials at the Texas Department of Transportation as well as from staff of other public agencies around the country.

1356-3, "Full-Cost Analysis of the Katy Freeway Corridor," by Jiefeng Qin, Michael T. Martello, José Weissmann, and Mark A. Euritt. Using a full-cost approach, this report evaluated the different transportation improvement alternatives (developed by Parsons Brinckerhoff Quade & Douglas, Inc.) available for the IH-10 Katy Freeway corridor. Through MODECOST — a computer model based on the full-cost analysis concept — we found that the current facility cannot meet future traffic demands.

1356-4, "The Houston-Harte of San Angelo: A Case Study Application of a Full-Cost Model for Evaluating Urban Passenger Transportation," by Karen M. Smith, Jiefeng Qin, José Weissmann, Mark A. Euritt, and Michael T. Martello. This report evaluates the full costs of transportation alternatives on the Houston-Harte corridor in San Angelo, Texas. The alternatives examined are those considered by the San Angelo District of the Texas Department of Transportation, which include: (1) the continuation of the existing frontage lanes-only configuration and (2) the construction of the mainlanes for completion of the facility. The results of MODECOST — a computer model developed by a Center for Transportation Research (CTR) team — indicate that the addition of mainlanes to the Houston-Harte corridor is both feasible and cost effective.

1356-5, "US 59 Harris County/Fort Bend County: A Case Study Application Of A Full-Cost Model For Evaluating Urban Passenger Transportation," by Michael T. Martello, Jiefeng Qin, José Weissmann, and Mark A. Euritt. This report evaluated transportation improvement alternatives for the US 59 Southwest Freeway corridor from the full-cost, life-cycle approach perspective. The alternatives involve hypothetical facility improvements as well as vehicle occupancy improvements. Our findings suggest that the current facility will not be able to service the projected peak-hour traffic demand; and after running MODECOST — a computer model based on the full-cost analysis concept — we observed that travelers bore a significant amount of external costs, including congestion costs and air pollution costs.

1356-6, "Application of Full Cost of Urban Passenger Transportation Case Study: Northeast (Ih-35) Corridor," by Jiefeng Qin, Michael T. Martello, José Weissmann, and Mark A. Euritt. Using a full-cost approach, we evaluated the different transportation improvement alternatives (developed by Rust Lichliter/Jameson) available for the Northeast (IH-35) corridor in San Antonio, Texas. Through MODECOST — a computer model based on the full-cost analysis concept — we found that the current facility cannot meet future traffic demands.

1356-7, "Full-Cost Evaluation of the Northeast Transit Terminal in El Paso, Texas," by Michael T. Martello, Jiefeng Qin, José Weissmann, and Mark A. Euritt. This report presents the results of an evaluation of the cost effectiveness of the Northeast Transit Terminal, an existing Sun Metro bus transit terminal located 23 km north of downtown El Paso, Texas. The evaluation of the transit terminal's cost effectiveness was conducted from a full-cost perspective and consisted of hypothesizing the amount of existing bus ridership that is attributable to the presence of the transit terminal. MODECOST, a computer model developed through this project, was used for the analysis.

1356-8F, "Development of an Urban Transportation Investment Model: Executive Summary," by Michael T. Martello, José Weissmann, Mark A. Euritt, and Jiefeng Qin. This final report summarizes the objectives of the project and provides recommendations for implementation.

DISCLAIMERS

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SUMMARY

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CHAPTER 1. INTRODUCTION

The main objective of this report is to assist Texas policy-makers in evaluating the various investment alternatives available for improving mobility within the Northeast (IH-35) corridor in San Antonio, Texas. Using full-cost analysis, we have calculated costs for five specific transportation alternatives for the Northeast (IH-35) corridor. This chapter reviews the background of full-cost analysis and outlines key elements of the report.

1.1. THE CONCEPT OF FULL-COST ANALYSIS

Over the past several decades, a vast transportation network has been developed to address mobility and accessibility needs in Texas. This state transportation network is dominated by more than 466,900 km of public roads (Ref 1), with more than 70 percent of local travel occurring within Texas cities having populations of 200,000 or more (Ref 2). Most of these trips are made by personal vehicles. And as is well known, such dependence on personal vehicles in Texas has created new problems for transportation professionals, environmentalists, and the public. These problems include congestion in many major metropolitan areas, air pollution and global weather change, noise, accidents, and energy depletion. The Federal Highway Administration (FHWA) reported that 25 percent of Texas' urban interstate highways exceed 95 percent of their capacity, and that 43 percent are operating at over 80 percent of their carrying capacity. Moreover, San Antonio, one of the largest cities in the nation, is very close to being classified as a non-attainment area. With the coming new standards by Environmental Protection Agency (EPA) and Texas Natural Resource Conservation Commission (TNRCC), it appears that the metropolitan area will be labeled as a non-attainment area.

Prior to 1990, transportation policy focused primarily on the development of the interstate system, with cost evaluations of urban transportation alternatives typically considering only initial capital investments. However, the passage of the Intermodal Surface Transportation Efficiency Act of 1991 (ISTEA) and the Clean Air Act Amendments of 1990 (CAAA) provided an opportunity to take a more comprehensive approach to evaluating transportation options. The ISTEA and CAAA shifted traditional planning and decision-making to a broader, multimodal transportation perspective, a process that examines highway, transit, and rail issues in combination. Using this broader view ensures that the transportation planning process looks at the problem from the perspective of an integrated system, emphasizing efficient and productive people and goods transfer from one location to another. Costs, including indirect social and environmental costs, must be fully accounted for in a comparison of modes and management strategies, in order to identify the most cost-effective options.

Transportation full-cost analysis is the first step in developing a multimodal transportation investment plan. Full-cost analysis takes into account not only infrastructure costs, but also user and external costs, thus enhancing transportation planning decisions significantly. Focus on any singular cost may result in an inefficient system and can lead to reduced long-term economic investment. The full-cost approach provides a stronger platform from which to evaluate transportation investment decisions without modal bias. It identifies least-cost alternatives, and promotes efficient use of the system.

1.2. A BRIEF REVIEW OF MODECOST MODEL

Previous reports (Refs 3, 4) have identified current practices relating to full-cost transportation planning. And in a previous effort, the Center for Transportation Research (CTR) of The University of Texas at Austin developed MODECOST, a computer model capable of comparing multimodal transportation alternatives by accounting for the full-cost for each mode. MODECOST incorporates many aspects of modal costs that have not traditionally been accounted for, such as air pollution cost, accident cost, and personal vehicle user cost. These costs are not usually included in decision matrices for transportation investment. By taking costs such as these into account, MODECOST can estimate the direct and indirect costs from the perspective of how much society or the taxpayer is paying for that mode of transportation.

In summary, MODECOST allows the transportation planner to compare the full-cost of three major urban transportation modes — auto, bus, and rail — along a particular corridor. It is based on the full-cost and life-cycle-cost concepts discussed in previous reports (Refs 3, 4). MODECOST is an easy-to-operate, interactive, and menu-driven software capable of comparing transportation alternatives. The software can be run on any IBM-PC or compatible computers using Microsoft Windows (Ref 5). Examples of MODECOST's input data dialog boxes and output files can be found in Appendix B.

1.3. SCOPE OF THE REPORT

This report summarizes and compares the five transportation alternatives for the Northeast (IH-35) corridor developed in the Major Investment Study (MIS) prepared by Rust Lichliter/Jameson. Comparing costs among alternatives can determine under what circumstances one alternative is more efficient than another in terms of the resources it uses to provide a given service. Accordingly, cost comparisons — particularly full-cost comparisons — can aid policy-makers in planning for new transportation infrastructure.

Chapter 2 is concerned with the background and development of the five alternatives for the Northeast (IH-35) developed by Rust Lichliter/Jameson. Chapter 3 describes the data inputs and assumptions made in the analysis. Chapters 4 builds on the calculations of MODECOST to present the full-cost of urban passenger transportation for different investment alternatives, presenting the results for each alternative. The last chapter, Chapter 5, summarizes the findings of this report.

CHAPTER 2. BACKGROUND

2.1. BACKGROUND OF CASE STUDY SITE

The Northeast (IH-35) corridor study section is 26 km long and extends from the intersection of IH-37 and US 281 in the downtown area to Loop 1604 on the north. The corridor is centered around IH-35, which is important not only as a major transportation corridor within Bexar County and San Antonio, but also as a heavily traveled interstate section connecting the North, Central, and South Texas regions with destinations to other important Texas cities. Increases in NAFTA-related trade moving through the corridor, along with projected growth in Bexar County's population and consumer-based economy, will certainly result in increased competition for the corridor's transportation capacity. Presently, IH-35 directly links Mexico to Canada, with easy connections to the northeastern manufacturing and population hubs.

In early 1996, the San Antonio/Bexar County Metropolitan Planning Organization (San Antonio MPO) undertook (with Rust Lichliter/Jameson) a comprehensive transportation study. The primary objective of that study was to provide the San Antonio MPO with a framework for evaluating the future transportation needs of the IH-35 Northeast corridor, particularly that portion running from the San Antonio Central Business District to Loop 1604.

Because sections of the current Northeast (IH-35) corridor were constructed several decades ago, planners fear that the corridor will be unable to accommodate future traffic growth. In addition, the escalating frequency of accidents has led to safety and mobility problems.

The study (dubbed a Major Investment Study, or MIS) is designed to comply with federal guidelines under the Intermodal Surface Transportation Efficiency Act (ISTEA) of 1991 (Ref 6). Specifically, the preliminary study by Rust Lichliter/Jameson accomplished the following tasks:

1. Developed an initial set of transportation improvement alternatives for the corridor, from the perspective of a multimodal transportation concept (highway, bus, rail, etc.).
2. Based on input from the public and from the participating transportation agencies, performed an initial evaluation and screening of the alternatives.

Based on the above guidelines, Rust Lichliter/Jameson identified three broad investment strategies for the Northeast (IH-35) corridor. These included:

1. No Investment, (i.e., Base Case)
2. Minimum improvements, (i.e., TSM/TDM)
3. Major improvements

Based on these criteria, ten alternatives were developed, including

1. A no-build alternative, (i.e., Base Case)
2. Two minimum investment alternative (i.e., minimal corridor operating system

improvement, and bus service improvements)

3. Seven major investment build alternatives (ranging from major interchange improvements to building rail transit)

The above options offer a varying degree of capacity enhancements meant to achieve study goals and objectives. In order to accommodate varying travel and physical characteristics along the full length of the corridor, the 25.9-km stretch of IH-35 was divided into six segments. Those segments included:

Segment 1: Loop 1604 to Fratt (8.29 km)
Segment 2: Fratt to Walzem (1.3 km)
Segment 3: Walzem to IH-35 and IH-410 Split (3.66 km)
Segment 4: IH-35 and IH-410 Split to BAMC (2.86 km)
Segment 5: BAMC to Pine Street (5.79 km)
Segment 6: Pine Street to Commerce Street (3.98 km)

Figure 2.1 depicts the study limits in San Antonio.

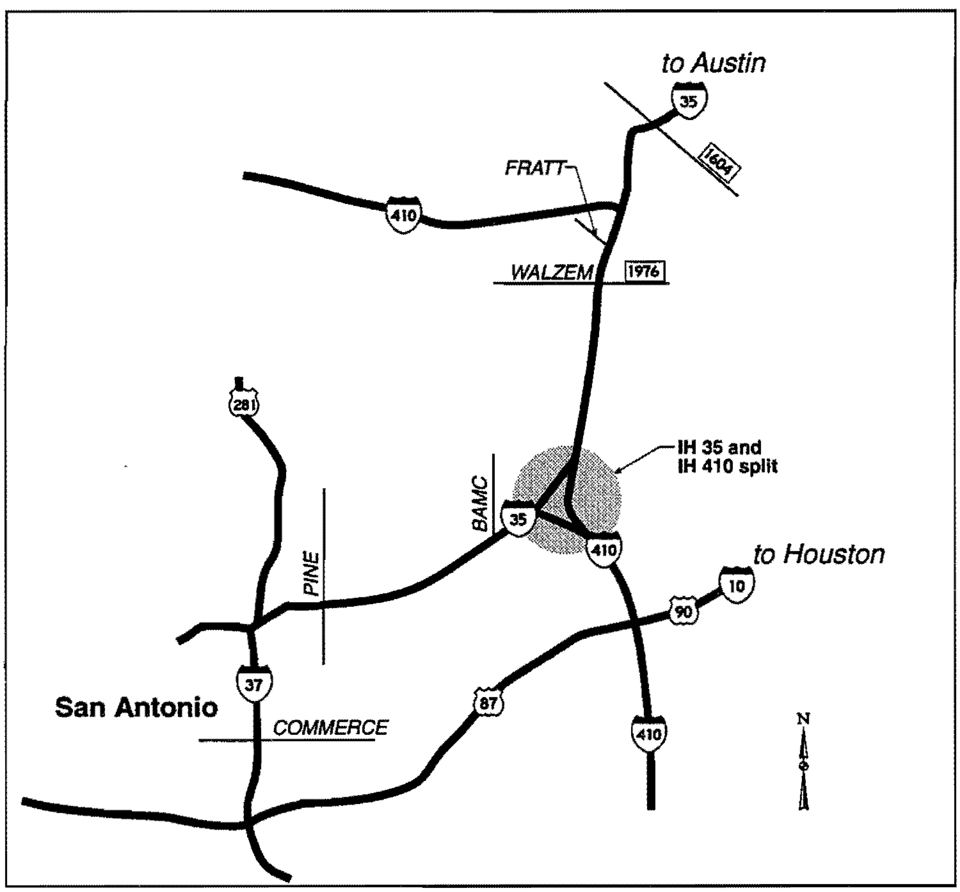


Figure 2.1 Study limits within San Antonio, Texas

The initial screening of each alternative was based on comparing the alternatives within a particular investment strategy. In comparing the alternatives within each investment strategy, it became clear that the alternatives under the same category had many similar characteristics. Differences among the alternatives occurred only across the investment strategies.

After comparing each investment category, we eliminated five alternatives that did not perform well, based on the initial screening criteria. The remaining five alternatives, including the Base Case, are shown in Figures 2.2 through 2.6. The details of these alternatives are summarized below:

Alternative 1: No Build (Base Case)

This alternative assumes that the current roadway configuration can meet future traffic demands. The Base Case is the benchmark alternative strategy to which all others are compared. It includes the existing system of highways and local streets and the presently operating transit system plus previously committed and funded improvements.

Alternative 2: General Purpose Lanes

This alternative includes major investments in General Purpose lanes. These investments include: (1) adding one general purpose lane in each direction from Fratt to Walzem, providing a total of ten general purpose lanes; (2) adding two general purpose lanes in each direction from Walzem to IH-35 and IH-410 Split, providing a total of five general purpose lanes in each direction; and (3) adding two general purpose lanes in each direction from BAMC to Pine Street, providing a total of ten general purpose lanes.

Alternative 3: HOV Lanes

This alternative includes major investments in HOV lanes. These investments include providing a one-lane, two-way HOV facility from Fratt to Commerce Street on the Northeast (IH-35) corridor.

Alternative 4: Express Lanes

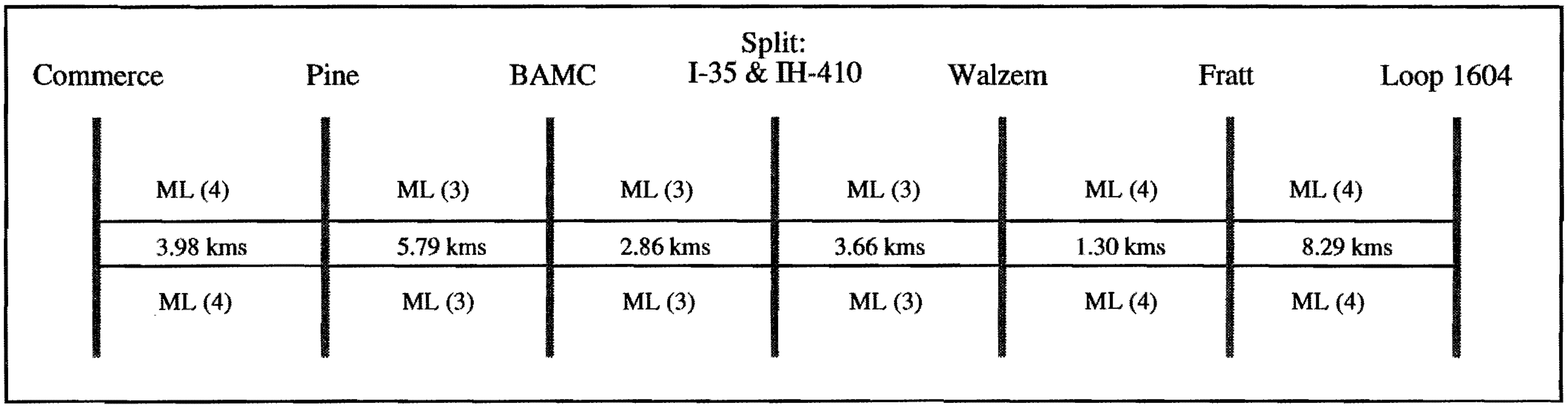
This alternative includes major investments in express lanes. These investments include adding a two-lane, two-way Expressway facility from Fratt to Pine Street along the Northeast (IH-35) corridor.

Alternative 5: Rail Transit

This alternative includes major investments in rail facilities. These investments include adding a high-level fixed guideway between Loop 1604 and Pine Street.

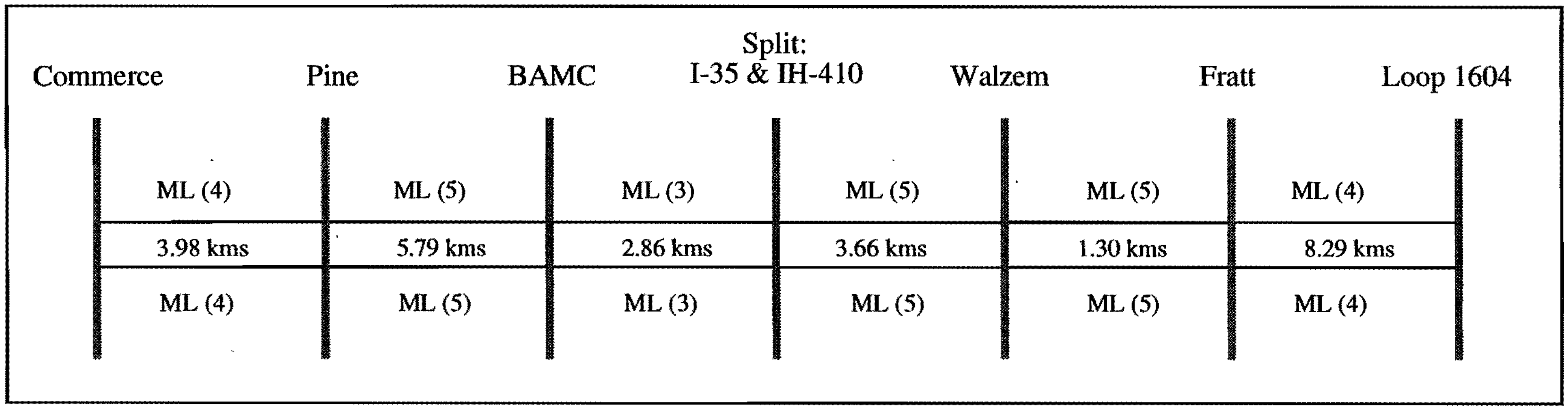
The next step in the study process, and the focus of this report, is to "screen" these five alternatives using a full-cost perspective to determine the alternative that performs best.

Figure 2.2. Alternative 1: No Build†



† – Number of lanes in each direction are shown in parentheses.

Figure 2.3. Alternative 2: General Purpose Lanes†



† – Number of lanes in each direction are shown in parentheses.

Figure 2.4. Alternative 3: HOV Lanes†

	Commerce – Pine	Pine – BAMC	BAMC – Split: I-35 & IH-410	Split: I-35 & IH-410 – Walzem	Walzem – Fratt	Fratt – Loop 1604
One direction	ML (4) HOV (1)	ML (3) HOV (1)	ML (3) HOV (1)	ML (3) HOV (1)	ML (4) HOV (1)	ML (4)
Length	3.98 kms	5.79 kms	2.86 kms	3.66 kms	1.30 kms	8.29 kms
Other direction	HOV (1) ML (4)	HOV (1) ML (3)	HOV (1) ML (3)	HOV (1) ML (3)	HOV (1) ML (4)	ML (4)

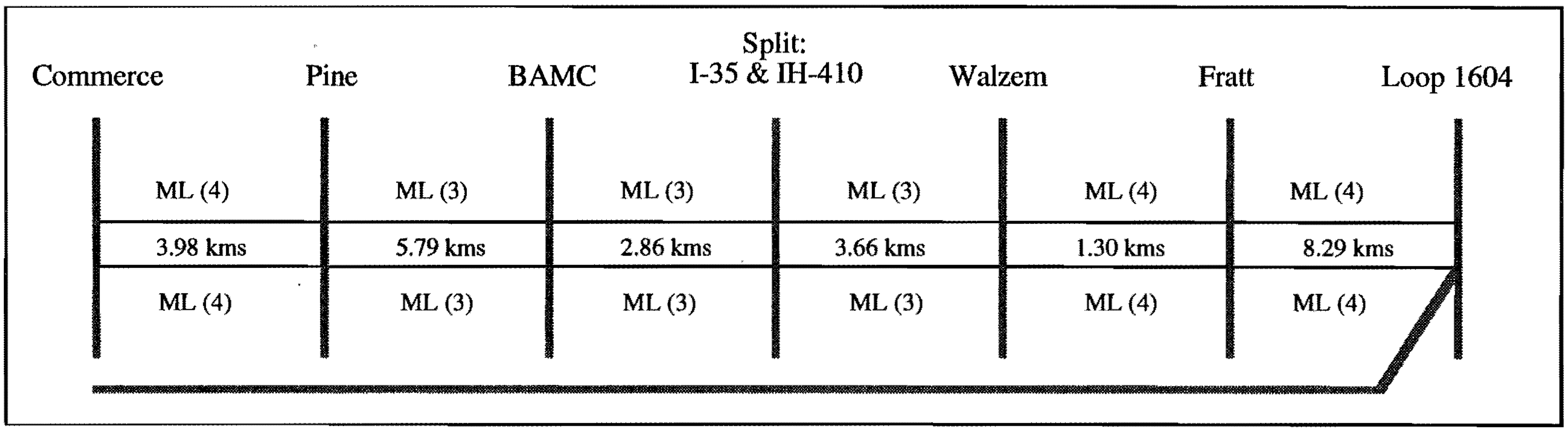
† – Number of lanes in each direction are shown in parentheses.

Figure 2.5. Alternative 4: Express Lanes†

Segment	Commerce – Pine	Pine – BAMC	BAMC – Split: I-35 & IH-410	Split: I-35 & IH-410 – Walzem	Walzem – Fratt	Fratt – Loop 1604
Upper	ML (4)	ML (3) EX (2)	ML (3) EX (2)	ML (3) EX (2)	ML (4) EX (2)	ML (4)
Length	3.98 kms	5.79 kms	2.86 kms	3.66 kms	1.30 kms	8.29 kms
Lower	ML (4)	EX (2) ML (3)	EX (2) ML (3)	EX (2) ML (3)	EX (2) ML (4)	ML (4)

† -- Number of lanes in each direction are shown in parentheses. EX represents express lanes.

Figure 2.6. Alternative 5: Rail†



† – Number of lanes in each direction are shown in parentheses.

CHAPTER 3. DESCRIPTION OF INPUT DATA

The objective of this study is to evaluate the future transportation needs of the Northeast (IH-35) corridor. Unlike the Major Investment Study, which examines only the transportation needs to the year 2015, we assume the planning horizon for Northeast (IH-35) corridor to be from the year 2000 to the year 2030. It is the purpose of this study to identify the investment that represents the best transportation alternative during this period, rather than that for a single year. In this chapter we discuss the data and assumptions used in our calculation.

3.1. PERSON-TRIP DEMAND

One of the most critical factors affecting final results is the person-trip demand. The San Antonio MPO and KPMG Peat Marwick LLP (KPMG) have already estimated future person-trip volumes on the corridor. Table 3.1 shows the average weekday 24-hour person-trip volumes for the year 2000. These data are estimated using the KPMG projection for the year 2015, assuming a 2 percent average annual growth rate during the analysis period (Ref 7). The weekend demand for each section, which is also shown in Table 3.1, is calculated based on our assumption that it is 75 percent of the corresponding weekday demand.

Table 3.1. Average Weekday Person-Trip Demand (year 2000)

Section on IH-35	Weekday		Weekend	
Freeway	Inbound	Outbound	Inbound	Outbound
Loop 1604 - Fratt	71,800	70,100	53,900	52,500
Fratt - Walzem	95,800	98,300	71,800	73,700
Walzem - Split	77,000	76,900	57,700	57,700
Split - BAMC	46,400	57,700	34,800	43,300
BAMC - Pine	77,900	73,700	58,500	55,300
Pine - Commerce	94,600	92,400	70,900	69,300

Source: KPMG (Ref 7).

3.2. FREIGHT TRUCK DEMAND

The movement of truck freight has a significant impact on local access within the Northeast (IH-35) corridor. Truck traffic uses the Northeast (IH-35) corridor to distribute goods to the local market and to access regional warehouse facilities. Truck traffic currently represents a significant percentage of the vehicle traffic in the study area, and freight movement through the corridor is expected to increase as trade with Mexico continues to grow as a result of NAFTA.

While the preliminary Major Investment Study does not estimate the corridor freight truck demand, it is the intention of our study to combine both person and freight movements. Our estimation of truck movement on Northeast (IH-35) corridor is based on the historical data obtained from a manual classification study that focused on an area northeast of Loop 1604 (Sta: M-1315). During the years 1987, 1988, 1990, and 1992, 86.63 percent of the vehicles moving through this station were classified as cars, pickups, and vans; 0.2 percent were categorized as buses; and the remainder was classified as freight trucks. Converted to a vehicle-trip basis, the truck demand at each section during weekday and weekend is described in Table 3.2.

In addition to the truck movements on IH-35, Station M-1315 also recorded the truck classification on the corridor. There are nine truck categories reported in the data, namely, 2-axle single unit, 3-axle single unit, 4-axle single unit, 3-axle semi-trailer, 4-axle semi-trailer, 5-axle semi-trailer, 6-axle semi-trailer, 5-axle trailer, and 6-axle trailer. Table 3.3 shows the truck mix on the corridor. The details of the calculation can be found in Appendix A.

Table 3.2. Weekday and Weekend Truck Demand (year 2000)

Section on Katy Freeway	Weekday		Weekend	
	Inbound	Outbound	Inbound	Outbound
Loop 1604 - Fratt	9,550	9,320	7,170	6,980
Fratt - Walzem	12,740	13,070	9,550	9,800
Walzem - Split	10,240	10,230	7,670	7,670
Split - BAMC	6,170	7,670	4,630	5,760
BAMC - Pine	10,360	9,800	7,780	7,360
Pine - Commerce	12,580	12,290	9,430	9,220

Table 3.3. Freight Truck Mix

Truck Category	Percentage (%)
2-axle Single Unit	21.2
3/4-axle Single Unit	4.3
3/4-axle Semi-Trailer	8.5
5-axle Semi-Trailer	61.4
6-axle Semi-Trailer	1.0
5-axle Trailer	2.6
6-axle Trailer	1.0
Total	100.0

3.3. MODE SPLIT AND VEHICLE OCCUPANCY

In addition to traffic demand along the corridor, mode split is another important issue affecting the transportation investment alternative comparisons. The mode split on the Northeast (IH-35) corridor varies from segment to segment, depending on the services provided by the transportation authorities in the region. As shown in the Travel Demand Forecasting Results Report (Ref 7), the number of bus users represents less than 1 percent of the total person-trip volumes, while the majority of travelers are using cars or carpools as their transportation. These figures are listed in Table 3.4.

Vehicle occupancy is another important factor. Higher vehicle occupancies reduce the total full cost of the facility. In this case study, the auto occupancy on the general purpose lanes and/or on the express lanes is 1.2 passengers per vehicle. The high-occupancy-vehicle has 2.4 passengers per vehicle, while bus has 8.6 passengers per bus and rail 40.0 passengers per rail car.

Table 3.4. Mode Split

Alternative	Section	Drive-Alone	Carpool*	Bus	Rail	Total
1 or 2	L1604 - Fratt	99.8%	N/A	0.2%	N/A	100%
	Fratt - Walzem	99.8%	N/A	0.2%	N/A	100%
	Walzem - Split	99.2%	N/A	0.8%	N/A	100%
	Split - BAMC	99.2%	N/A	0.8%	N/A	100%
	BAMC - Pine	99.7%	N/A	0.3%	N/A	100%
	Pine - Commerce	99.7%	N/A	0.3%	N/A	100%
3	L1604 - Fratt	99.8%	N/A	0.2%	N/A	100%
	Fratt - Walzem	92.6%	7.2%	0.2%	N/A	100%
	Walzem - Split	87.7%	11.5%	0.8%	N/A	100%
	Split - BAMC	82.4%	16.8%	0.8%	N/A	100%
	BAMC - Pine	78.8%	20.9%	0.3%	N/A	100%
	Pine - Commerce	82.7%	17.0%	0.3%	N/A	100%
4	L1604 - Fratt	99.8%	N/A	0.2%	N/A	100%
	Fratt - Walzem	80.3%	19.5%	0.2%	N/A	100%
	Walzem - Split	76.0%	23.2%	0.8%	N/A	100%
	Split - BAMC	66.5%	32.7%	0.8%	N/A	100%
	BAMC - Pine	54.3%	45.4%	0.3%	N/A	100%
	Pine - Commerce	99.7%	N/A	0.3%	N/A	100%
5	L1604 - Fratt	97.3%	N/A	0.2%	2.5%	100%
	Fratt - Walzem	97.3%	N/A	0.2%	2.5%	100%
	Walzem - Split	96.7%	N/A	0.8%	2.5%	100%
	Split - BAMC	96.7%	N/A	0.8%	2.5%	100%
	BAMC - Pine	97.2%	N/A	0.3%	2.5%	100%
	Pine - Commerce	97.2%	N/A	0.3%	2.5%	100%

* In alternative 4, this column expresses auto mode split on express lanes.

3.4. TRAFFIC DISTRIBUTION DURING PEAK AND NON-PEAK PERIODS

The Major Investment Study does not estimate the traffic distribution during peak and non-peak periods. Since there is no historical data collected for this region, we used the data reported in our previous report (Ref 8). The figures shown in Table 3.5 are in terms of percent of total movements, representing simply the traffic for each direction as a fraction of total vehicle-trips on that section. There is a 1-hour peak period in the morning and afternoon. The share during the "Night" period (10:00 p.m. – 6:00 a.m.) in each direction is assumed to be 3.0 percent of the total trips, based on the national average derived by Hu (Ref 9). The remaining trips are assumed to occur during the "Day" period.

Table 3.5. Weekday Traffic Distribution (in % of Vehicle-Trips)

	AM Peak		PM Peak		Day		Night	
Weekday/Weekend	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound	Inbound	Outbound
Weekday	5.0	5.0	5.0	5.0	37.0	37.0	3.0	3.0
Weekend	0.0	0.0	0.0	0.0	47.0	47.0	3.0	3.0

Since there were no data collected for weekends, it is assumed that there is no peak-hour period on the weekends. Ninety-four percent of weekend traffic is assumed to travel through the Northeast (IH-35) corridor during the "Day" period (6:00 a.m. – 10:00 p.m.), and the remaining during the "Night" period, as shown in Table 3.5.

3.5. VALUE OF TIME

Although the inclusion of travel time costs in the analysis renders the results more meaningful, it also introduces questions about some of the assumptions. Passenger travel-time values are difficult to measure, and various studies have disagreed regarding the appropriate estimate for the value of travel time. Furthermore, some planners are skeptical of methods that rely on a single assumed value for travel time. However, from the perspective of alternative comparisons, the single value method is adequate. In this analysis we assume a value of $7.09 per passenger per hour for travel time. The value equals to 80 percent of the Bexar County wage rate (Ref 7).

3.6. FACILITY COST DATA

Most data on facility unit costs have been taken from the *General Guidelines for Estimates* provided by the Texas Department of Transportation. We assume the existing right-of-way is large enough to accommodate either the expansion of the facility or the addition of a new facility; therefore, the purchase of right-of-way is not included in this study.

3.7. EMISSION VALUE DATA

The emission values, which are based primarily on damage value estimates of stationary source emissions, are calculated based on the following formulas (Ref 10):

$$V_{NOx} = 1640 \cdot \ln(pop) + 4220 \cdot \ln(O_3)$$

$$V_{HC} = 871 \cdot \ln(pop) + 2310 \cdot \ln(O_3)$$

$$\ln(V_{PM10}) = 0.764 \cdot \ln(pop) + 0.685 \cdot \ln(PM_{10})$$

$$\ln(V_{SOx}) = 5.41 + 0.325 \cdot \ln(pop) + 0.0138 \cdot \ln(SO_2)$$

$$V_{CO} = -6390 + 579 \cdot \ln(pop) + 2110 \cdot \ln(CO)$$

where

V_p = damage value ($/ton) for pollutant p;
pop = total population (in 10^3);
O_3 = highest second daily maximum 1-hr ozone concentration (ppm);
PM_{10} = highest arithmetic mean PM_{10} concentration ($\mu g/m^3$);
SO_2 = highest arithmetic mean SO_2 concentration (ppm); and
CO = highest second maximum nonoverlapping 8-hr CO concentration (ppm).

Using the above relationships, we have estimated emission values for the San Antonio metropolitan area. Table 3.6 presents data on air pollutant concentrations and population in the San Antonio area. In applying these data to the regression relationships to estimate emission values, we found that the values are $2,447 per ton for nitrogen oxides (NO_X), $1,150 per ton for hydrocarbons (HC), $4,090 per ton for soot-like particulate (PM10), $2,150 per ton for sulfur oxides (SO_X), and $1,160 per ton for carbon monoxide (CO).

Table 3.6. Input Data Used in Regression Relationships

Population (in 10^3)	1,302
O_3 (ppm)	0.11
PM_{10} ($\mu g/m^3$)	63
SO_2 (ppm)	0.008
CO (ppm)	5

3.8. TRANSIT AGENCY DATA

The bus fleet running on the Northeast (IH-35) corridor consists of the Low-Floor, 12 m, New Flyer, which has an initial capital cost of $257,000 per bus and a life span of 12 years. In

1992, VIA Metropolitan Transit had an operating expense $49,457,403 on 153,004,068 total passenger miles of travel (PMT), which is equivalent to $0.32 per PMT.

3.9. CAPITAL AND OPERATING DATA FOR PERSONAL VEHICLE

The cost of owning and operating a motor vehicle is of major significance. The data listed in Table 3.7, provided by the FHWA, trace selected vehicles in personal use and their costs through a 12-year lifetime (Ref 11). The costs were based on operation of typical vehicles.

Table 3.7. Auto Capital and Operating Data

Cost Category	Cost
Average Vehicle Price ($/vehicle)	13,534
Average Pickup and Van Price ($/vehicle)	15,813
Percent being Financed	75%
Loan Period (year)	5
Loan Rate	10.0%
Salvage Value ($/vehicle)	1,000
Vehicle Life (year)	12
Average Annual Driven Miles (mile)	10,700
Annual Scheduled Maintenance ($/vehicle)	232
Annual Unscheduled Maintenance ($/vehicle)	195
Annual Oil Change ($/vehicle)	59
Annual Tire Change ($/vehicle)	97
Annual Insurance ($/vehicle)	600
Annual Parking ($/vehicle)	360
Enhanced I/M ($/vehicle)	55
Average Gasoline Price without Taxes ($/gallon)	0.70

Source: *Cost of Owning & Operating Automobiles, Vans & Light Trucks 1991*. U.S. Department of Transportation, Washington, D.C., 1992.

3.10. RAIL DATA

Table 3.8 reports the additional data used to calculate the capital cost of the fixed guideway system (Ref). All rail facilities are assumed to have 40-year life spans in this study. The rehabilitation costs and maintenance costs of the facilities, as well as the operation data of the rail system, are detailed in the previous report (Ref 4).

Table 3.8. Capital Cost Data of Fixed Guideway

Guideway	Unit Cost (per km)	$1,770,000
	Length	27.7 miles
Stations	Unit Cost (per Station)	$9,000,000
	Number	10 Stations
Yards and Shops	Cost	$13,250,000
	Number	1 Yard
Rail Car	Unit Cost (per Car)	$2,000,000

3.11. OTHER DATA

In 1992, the annual vehicle-miles of travel (AVMT) in San Antonio was 9 billion, 40.2 percent of which was on expressways (Ref 1). By using a TxDOT-projected VMT growth rate,[1] it is expected that the AVMT will grow to 10.5 billion by the year 2000.

Concerning the value of money over time, the discount rate used in the study to convert all costs into 1995 dollars is 10 percent.

[1] Statewide VMT projection by the Texas Department of Transportation.

CHAPTER 4. RESULTS

4.1. BASE ALTERNATIVE

Alternative 1 (No Build) was considered as the base case in our analysis. The analysis for this alternative consists of cost calculations for each of the six previously defined sections along Northeast (IH-35) corridor. The cost summary reflects the impact of future traffic on the current facilities. The details, summarized in Table 4.1, are divided into eight cost categories, namely, facility costs, transit agency costs, travel time costs, air pollution costs, incident delay costs, accident costs, other external costs, and user costs.

Facility costs include roadway construction, rehabilitation, routine maintenance, and administration costs. Transit agency costs consist of the capital and operating cost paid by transit agencies if there is a transit service running on the corridor. Travel time costs are the time costs expended on the road by users. This part of the costs includes non-incident, congestion-related time costs. Air pollution costs, which are closely related to the congestion levels of the facility, are the result of tailpipe emissions. Incident delay costs result from the delay caused by incidents, while accident costs are those costs not covered by insurance — the part paid by society. Other external costs include energy security, weather change, water pollution, and noise costs. Finally, user costs include the costs paid by private vehicle owners to operate and maintain their vehicles.

In Base Case, the travel time costs on Northeast (IH-35) corridor for the 30-year analysis period is a dominant force among all the cost categories. The annual user travel time and incident delay costs will account for more than 60 percent of the total annual cost. The pollution costs, which are closely related to the dimension of the facility, rank third with $42 million a year. Auto users spend about $310 million per year, or slightly more than one quarter of the total cost, to own and operate their vehicles. The facility costs, which include all the labor and material costs to maintain the current roadway facility, occupy only 2 percent of the pie.

Looking at the annual cost by section, the section from BAMC to Pine has the largest share — about 30 percent of the total cost occurring within this segment. The travel time cost within this section is about 34 percent of the total travel time cost of the entire corridor, though its person-miles of travel (PMT) is only 22 percent of the total PMT, a result of the insufficient capacity in this section. The v/c ratio during peak hours in this section is 1.22 for the year 2000, almost one-fourth over the current capacity. It will quickly reach 1.49 by the year 2010 and 1.81 by the year 2020. The inadequate capacity causes excessive delay to through traffic and local traffic. The frequent stop-and-go caused by large v/c ratio results in a tremendous amount of tailpipe emissions from the traffic, which in turn leads to large air pollution costs. The same situations occur on the sections from Walzem to Split (IH-35 and IH-410) and from Pine to Commerce. This suggests that the expansion of the capacity on these sections is very urgent and necessary.

In the next section, we will evaluate the other proposed alternatives and the potential of these alternatives in terms of alleviating congestion and reducing total cost.

Table 4.1. Annual Life-Cycle Cost of Alternative 1 (in million dollars)

Alternative 1 No Build	Commerce – Pine	Pine – BAMC	BAMC – Split: I-35 & IH-410	Split: I-35 & IH-410 – Walzem	Walzem – Fratt	Fratt – Loop 1604	Total
	ML (4)	ML (3)	ML (3)	ML (3)	ML (4)	ML (4)	
	3.98 kms	5.79 kms	2.86 kms	3.66 kms	1.30 kms	8.29 kms	25.86 kms
	ML (4)	ML (3)	ML (3)	ML (3)	ML (4)	ML (4)	

Annual Cost	**Agency**	**2.95**	**4.44**	**2.29**	**2.81**	**1.10**	**6.34**	**19.93**
	Highway Faciltiy	2.77	4.23	2.10	2.44	1.06	6.15	18.76
	Transit Agency	0.18	0.21	0.19	0.36	0.04	0.19	1.17
	Auto User	**59.02**	**69.75**	**23.56**	**44.61**	**20.11**	**93.47**	**310.51**
	External	**158.45**	**289.11**	**26.83**	**199.25**	**66.14**	**110.08**	**849.85**
	Travel Time	131.78	254.00	17.35	176.27	56.63	72.51	708.53
	Air Pollution	7.79	12.80	1.92	8.66	3.08	7.70	41.94
	Incident Delay	6.52	7.71	2.62	4.95	2.22	10.32	34.33
	Accident	1.74	2.06	0.70	1.32	0.59	2.76	9.16
	Other External	10.62	12.55	4.25	8.05	3.62	16.81	55.90
	Total	**220.41**	**363.30**	**52.68**	**246.66**	**87.34**	**209.89**	**1180.29**

Initial Capital Cost†	19.61	31.17	15.49	17.83	7.66	43.87	135.64

† Initial capital cost is the initial lump-sum highway facility (excluding frontage roads) cost, excluding rail grade separation, interchange improvements, and mobilization and traffic control cost.

4.2. OTHER ALTERNATIVES

The major objective of this report is to identify and evaluate the alternatives available for reducing total transportation costs on the Northeast (IH-35) corridor throughout a planning horizon of 30 years. The base alternative presented previously provides the baseline to compare the other four alternatives. The base alternative reflects the current situation for the Northeast (IH-35) corridor, as well as the future trend based on no additional investment. In this section, we discuss four other alternatives:

Alternative 2: General Purpose Lanes
Alternative 3: HOV Lanes
Alternative 4: Express Lanes
Alternative 5: Rail

The analysis was completed using both the MODECOST program and the same assumptions as those used for the base case reported previously. The analysis includes not only facility costs, but also external costs as well as user and agency costs. The costs are categorized according to eight cost groups, as described in the previous section. In addition, we also estimated the initial capital cost for each alternative, based on the output from MODECOST.

The four alternatives, discussed in Chapter 2, proposed the expansion of the current facility, which was shown clearly in the previous section as being unable to handle future traffic growth. The four investment strategies range from expanding the existing general purpose lanes, to building HOV lanes, express lanes, or a light rail system. The results for the analysis are presented in Tables 4.2 through 4.4.

Table 4.2 lists the annual life-cycle cost of Alternative 2, which shows a clear improvement from the base alternative. The annual total cost drops more than one-third from $1.18 billion to $765 million. Among eight cost categories, the travel time costs have the largest drop, from over $708 million a year to $307 million a year. The next is air pollution costs, which drop by one-third a year. This implies that the traffic flow on the corridor has been dramatically improved.

Looking at the results by section, the travel time and pollution costs on sections from Walzem to Split and from BAMC to Pine show tremendous improvement, which implies that the congestion level is eased significantly. The remainder of the sections, however, shows minimum gains.

Table 4.3 shows the cost results for Alternative 3. Compared with the base alternative, Alternative 3 has the same impact as Alternative 2 in alleviating congestion on the corridor. The travel time savings of Alternative 3 top $360 million a year. And the annual air pollution savings total almost $14 million.

The travel time and delay cost on the section from Pine to Commerce improves significantly, reducing from $138 million to only $65 million a year. This shows the tremendous advantage of improving the current roadway geometry on this section.

Breaking down the cost by categories, as shown in Table 4.3, we can see that auto user costs are a major contributor to the total cost, reaching more than one-third of the annual cost. Comparing this with the base scenario, travel time cost is down, from 60 percent to 44 percent. This illustrates that the current facility is incapable of handling future traffic growth. Although Alternative 3 increases annual agency costs by $4 million, the tremendous savings on external costs and automobile user costs reduce the total annual cost by one-third from the base scenario.

The results for Alternative 4 are listed in Tables 4.4. This alternative can effectively reduce travel time cost and air pollution cost, achieving the same goal as did Alternatives 2 and 3.

Table 4.5 lists the full-cost results obtained from MODECOST for Alternative 5 — the rail alternative. The results show that including a fixed guideway option is not a feasible alternative. This is because the light rail system cannot attract large ridership, leaving the existing Northeast (IH-35) corridor as the major corridor to serve commuters. As shown in the demand forecasting report (Ref 7), the mode split shifting from automobile to rail transit is minimum. The sections from Walzem to Split and from BAMC to Pine remain heavily congested.

As discussed above, Alternative 2, Alternative 3, and Alternative 4 have a tremendous positive impact on the total future transportation cost. Overall, Alternative 2 has a lower annual cost as well as a lower initial investment. The extension of an HOV lane from Pine to downtown San Antonio in Alternative 3 alleviates the congestion on this section considerably. In both Alternative 2 and 4, however, the roadway expansion is restricted to the north of Pine, leaving the section from Pine to Commerce congested with future traffic.

Table 4.2. Annual Life-Cycle Cost of Alternative 2 (in million dollars)

Alternative 2 General Purpose Lanes	Commerce – Pine	Pine – BAMC	BAMC – Split: I-35 & IH-410	Split: I-35 & IH-410 – Walzem	Walzem – Fratt	Fratt – Loop 1604	Total
	ML (4)	ML (5)	ML (3)	ML (5)	ML (5)	ML (4)	
	3.98 kms	5.79 kms	2.86 kms	3.66 kms	1.30 kms	8.29 kms	25.86 kms
	ML (4)	ML (5)	ML (3)	ML (5)	ML (5)	ML (4)	

Annual Cost	**Agency**	**2.95**	**5.02**	**2.29**	**3.17**	**1.17**	**6.34**	**20.94**
	Highway Faciltiy	2.77	4.81	2.10	2.81	1.13	6.15	19.77
	Transit Agency	0.18	0.21	0.19	0.36	0.04	0.19	1.17
	Auto User	**59.02**	**69.75**	**23.56**	**44.61**	**20.15**	**93.47**	**310.55**
	External	**158.45**	**66.99**	**26.83**	**43.64**	**27.97**	**110.08**	**433.97**
	Travel Time	131.78	39.27	17.35	25.85	19.76	72.51	306.52
	Air Pollution	7.79	5.41	1.92	3.48	1.78	7.70	28.06
	Incident Delay	6.52	7.71	2.62	4.95	2.22	10.32	34.33
	Accident	1.74	2.06	0.70	1.32	0.59	2.76	9.16
	Other External	10.62	12.55	4.25	8.05	3.62	16.81	55.90
	Total	**220.41**	**141.77**	**52.68**	**91.43**	**49.29**	**209.89**	**765.46**

Initial Capital Cost†	19.61	40.77	15.49	29.48	8.96	43.87	158.18

† Initial capital cost is the initial lump-sum highway facility (excluding frontage roads) cost, excluding rail grade separation, interchange improvements, and mobilization and traffic control cost.

Table 4.5. Annual Life-Cycle Cost of Alternative 5 (in million dollars)

	Commerce – Pine	Pine – BAMC	BAMC – Split: I-35 & IH-410	Split: I-35 & IH-410 – Walzem	Walzem – Fratt	Fratt – Loop 1604	
Alternative 5 Rail	ML (4)	ML (3)	ML (3)	ML (3)	ML (4)	ML (4)	**Total**
	3.98 kms	5.79 kms	2.86 kms	3.66 kms	1.30 kms	8.29 kms	25.86 kms
	ML (4)	ML (3)	ML (3)	ML (3)	ML (4)	ML (4)	

Annual Cost	**Agency**	**4.38**	**5.60**	**3.09**	**3.98**	**2.59**	**7.42**	**27.06**
	Highway Faciltiy	2.77	4.23	2.10	2.44	1.06	6.15	18.76
	Transit Agency	1.61	1.37	0.99	1.54	1.52	1.27	8.30
	Auto User	**57.54**	**68.00**	**22.97**	**43.49**	**19.60**	**91.13**	**302.73**
	External	**140.68**	**252.32**	**25.87**	**173.81**	**58.75**	**104.84**	**756.27**
	Travel Time	115.10	219.05	16.61	152.09	49.68	68.14	620.67
	Air Pollution	7.12	11.44	1.86	7.72	2.79	7.47	38.39
	Incident Delay	6.38	7.54	2.56	4.84	2.17	10.09	33.57
	Accident	1.70	2.01	0.68	1.29	0.58	2.70	8.96
	Other External	10.39	12.28	4.16	7.87	3.54	16.45	54.68
	Total	**202.60**	**325.92**	**51.93**	**221.28**	**80.94**	**203.39**	**1086.05**

Initial Capital Cost	Highway†	19.61	31.17	15.49	17.83	7.66	43.87	135.64
	Rail	168.85						168.85

† Initial capital cost is the initial lump-sum highway facility (excluding frontage roads) cost, excluding rail grade separation, interchange improvements, and mobilization and traffic control cost.

CHAPTER 5. CONCLUSION

This case study followed the development of MODECOST, a computer model capable of estimating the total costs of transportation alternatives for a given corridor. The estimations are based on the characteristics of the corridor, the characteristics of traffic on the corridor, the transportation modes to be evaluated, and on the modal split.

Our analysis of the five alternatives indicates that there is potential for a one-third decrease in total transportation costs on the Northeast (IH-35) corridor. This decrease in total transportation costs is relative to the current facility being used from the years 2000 through 2030. Compared with the potential total savings, including time savings and air pollution savings from easing congestion, the initial capital investment is relatively small.

As reported in a previous chapter, the current facility from Walzem to Split (IH-35 and IH-410) and from BAMC to downtown San Antonio cannot accommodate future traffic growth. The section from BAMC to Pine is the poorest in terms of traffic delay and air pollution costs. The demand on the section will exceed the current capacity by 25 percent by the year 2000, and 80 percent by the year 2020; adding General Purpose lanes or HOV lanes can result in tremendous savings.

We should point out that building a rail facility along the corridor cannot adequately alleviate future traffic congestion on the Northeast (IH-35) corridor, simply because the mode shift from auto to rail is not large enough.

Comparing the four investment strategies proposed by Rust Lichliter/Jameson, we found that Alternative 2 (adding general purpose lanes) is the best. Alternative 3 (adding HOV lanes) and Alternative 4 (adding express lanes) are nearly equivalent. These three alternatives have a clear advantage over Alternative 5 (rail). The differences among the results of these three alternatives are largely due to the estimation of traffic demand and mode split.

In the base alternative with no investment, travel time and delay costs dominated the cost categories owing to the insufficient capacity of the facility. In Alternative 2 through Alternative 4, the user/agency costs account for the largest share, being responsible for almost 40 percent of the total cost.

As discussed earlier, full-cost analysis allows us to look at the transportation planning process from the perspective of an integrated system. Full-cost evaluations of urban transportation alternatives take into account not only initial capital investments, but also indirect social and environmental costs. If we use only initial investment as our "screen" criteria, we will obviously choose Alternative 1 as our final recommendation, as shown in Figure 5.1. From the perspective of full cost, however, Alternative 2 is the best choice, as shown in Figure 5.2. Compared with Alternatives 1 and 5, Alternative 2, Alternative 3, and Alternative 4 have a clear advantage, based on their over $400 million annual savings obtained largely from reductions in user and external costs. Figures 5.1 and 5.2 illustrate that when evaluating transportation alternatives, a full-cost approach has an obvious advantage over traditional transportation planning. Emphasizing initial capital investment could, over the long-term, redound to an inefficient transportation system.

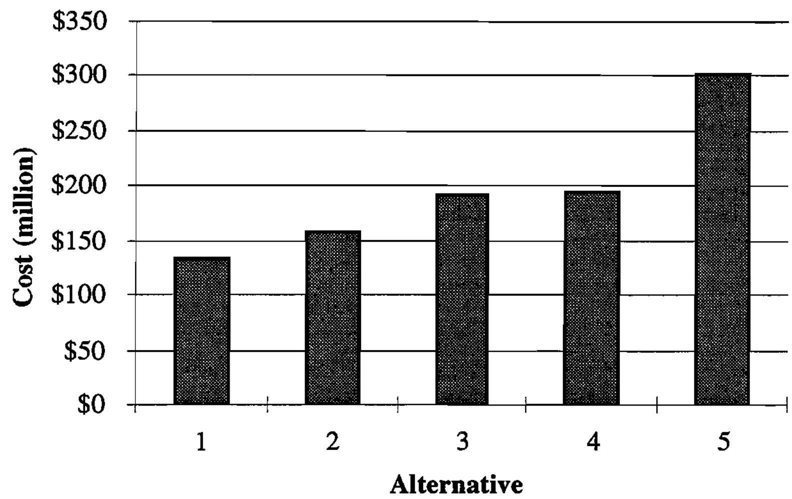


Figure 5.1. Initial Investment by Alternatives

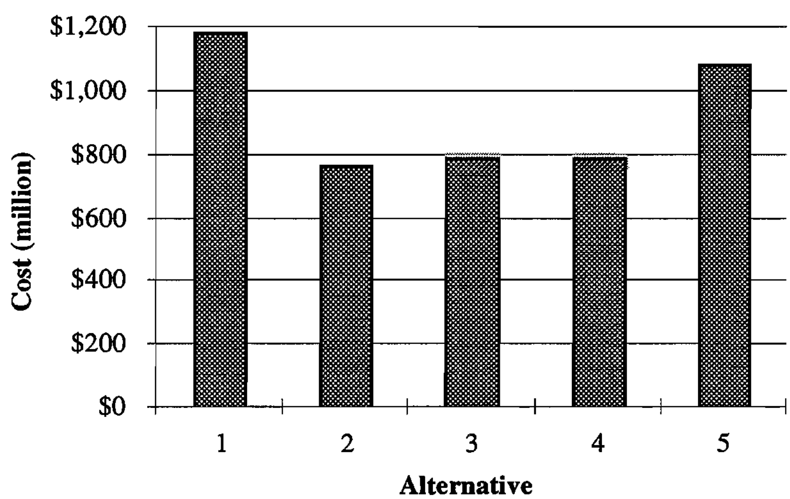


Figure 5.2. Annual Cost by Alternatives

The full-cost approach takes into account not only facility investment, but also external costs and user expenditures. The case study conducted in this report shows that, in many cases, the latter is more important than the former. The full-cost analysis results reported are effective not only in comparing alternatives, but also in enhancing qualitative assessments and planning/engineering judgment. The full-cost values calculated for the several alternatives can thus be used by policy-makers and transportation professionals as an assessment indicator.

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APPENDIX A

ESTIMATION OF FREIGHT TRUCK DEMAND AND TRUCK MIX

APPENDIX A

ESTIMATION OF FREIGHT TRUCK DEMAND AND TRUCK MIX

The following table lists the number and classification of vehicles observed at Station M-1315 near Northeast (IH-35) corridor (Bexar County) for the years 1987, 1988, 1990, and 1992.

Table A.1. Vehicles Classified at Manual Count Station (M-1315)

Year	1987		1988		1990		1992		Average
	Number	Percentage	Number	Percentage	Number	Percentage	Number	Percentage	Percentage
Cars	23316	61.36%	28043	56.79%	24376	59.24%	29277	70.95%	62.08%
Busses	90	0.24%	88	0.18%	89	0.22%	73	0.18%	0.20%
Panel & Pickup	9735	25.62%	14737	29.84%	11245	27.33%	6366	15.43%	24.55%
Other 2-Axle Single Unit	1151	3.03%	1272	2.58%	1273	3.09%	1009	2.45%	2.79%
3-Axle Single Unit	220	0.58%	350	0.71%	199	0.48%	180	0.44%	0.55%
4-Axle Single Unit	14	0.04%	5	0.01%	11	0.03%	2	0.00%	0.02%
3-Axle Semi-Trailer	121	0.32%	155	0.31%	173	0.42%	137	0.33%	0.35%
4-Axle Semi-Trailer	446	1.17%	397	0.80%	261	0.63%	207	0.50%	0.78%
5-Axle Semi-Trailer	2718	7.15%	4005	8.11%	3297	8.01%	3729	9.04%	8.08%
6-Axle Semi-Trailer	32	0.08%	123	0.25%	25	0.06%	33	0.08%	0.12%
5-Axle Trailer	119	0.31%	172	0.35%	165	0.40%	164	0.40%	0.36%
6-AxleTrailer	38	0.10%	35	0.07%	36	0.09%	88	0.21%	0.12%
Total	38000	100.00%	49382	100.00%	41150	100.00%	41265	100.00%	100.00%

APPENDIX B

INPUT AND OUTPUT DATA OF MODECOST

APPENDIX B

INPUT AND OUTPUT DATA OF MODECOST

Since we divided the entire corridor into six segments, there are a total of six runs for each alternative. Owing to space limitations, we provide only a sample of the input and output data.

The following are the input and output data from the analysis of segment 3, which runs from Walzem to Split, in alternative 1.

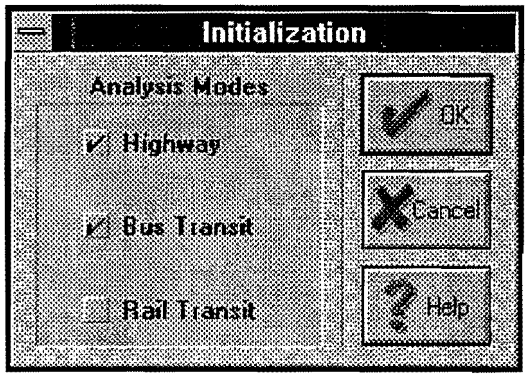

Figure D.1. Input Dialog Box 1 -- Initialization

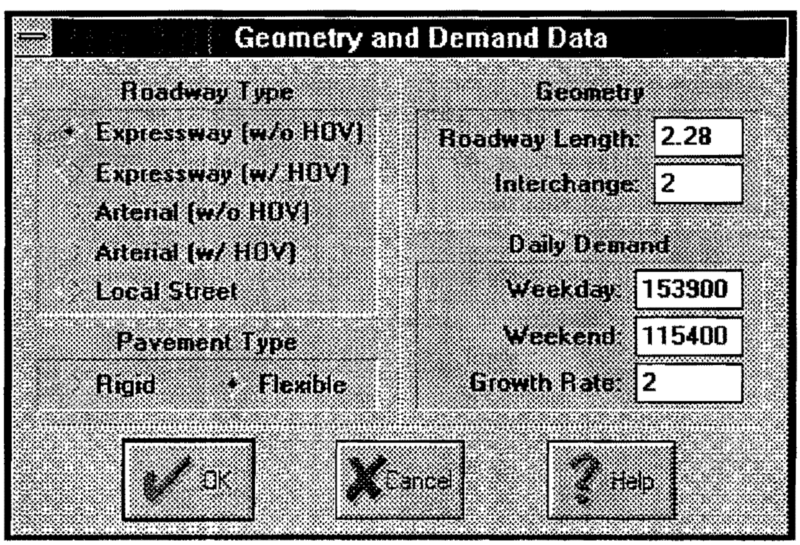

Figure D-2. Input Dialog Box 2 -- Geometry and Demand Data

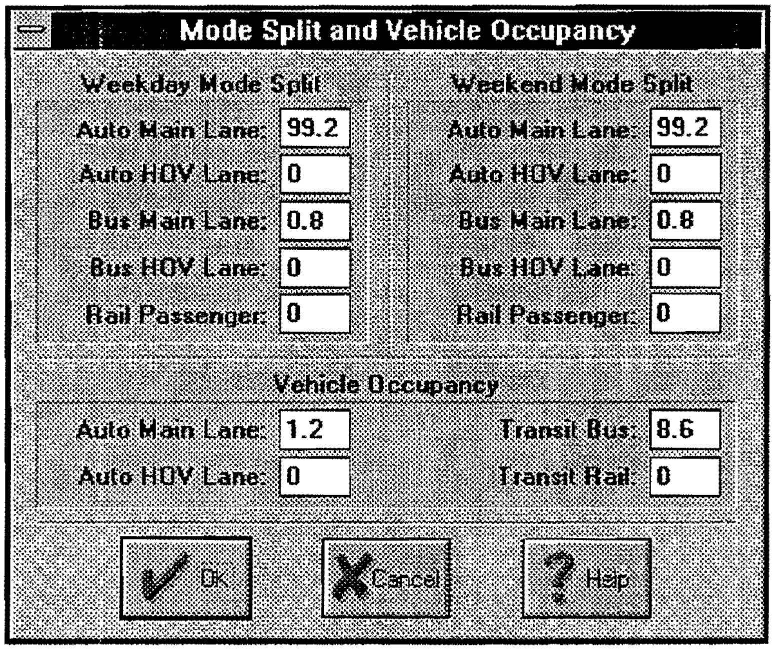

Figure D.3. Input Dialog Box 3 -- Mode Split and Occupancy Data

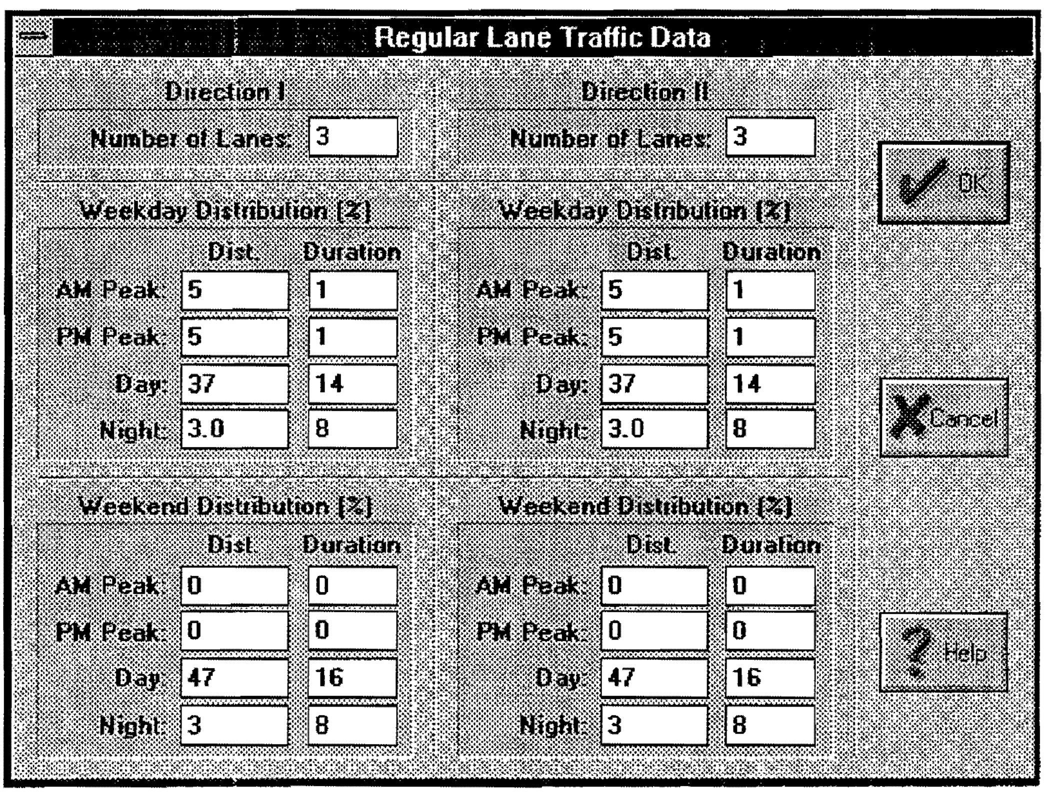

Figure D.4. Input Dialog Box 4 -- Regular Lane Traffic Data

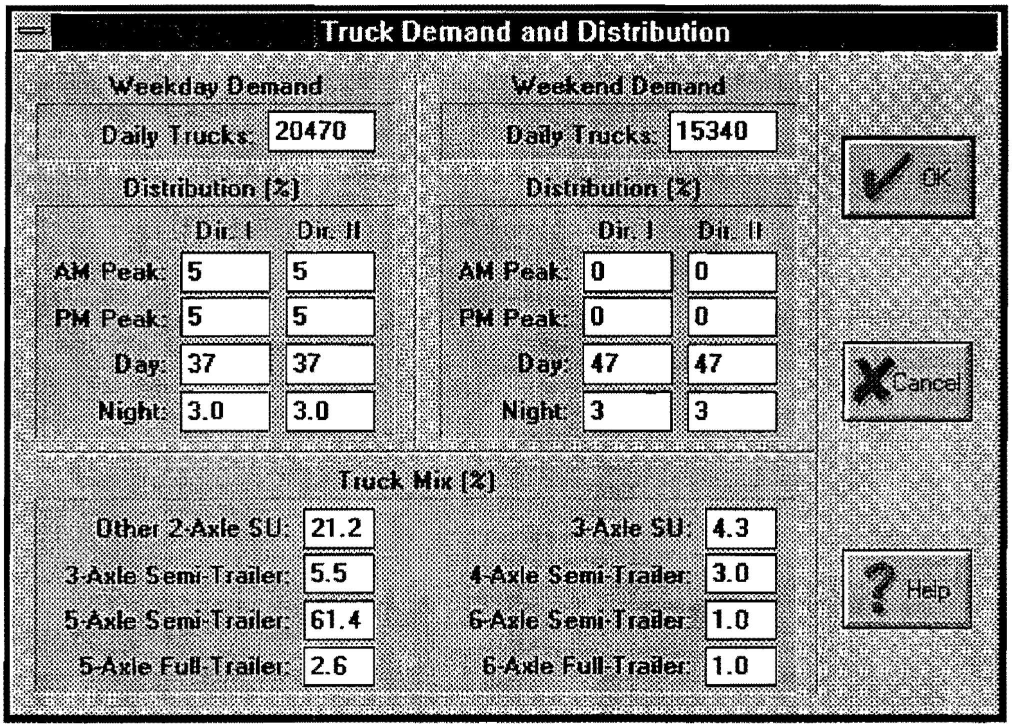

Figure D.5. Input Dialog Box 5 -- Truck Data

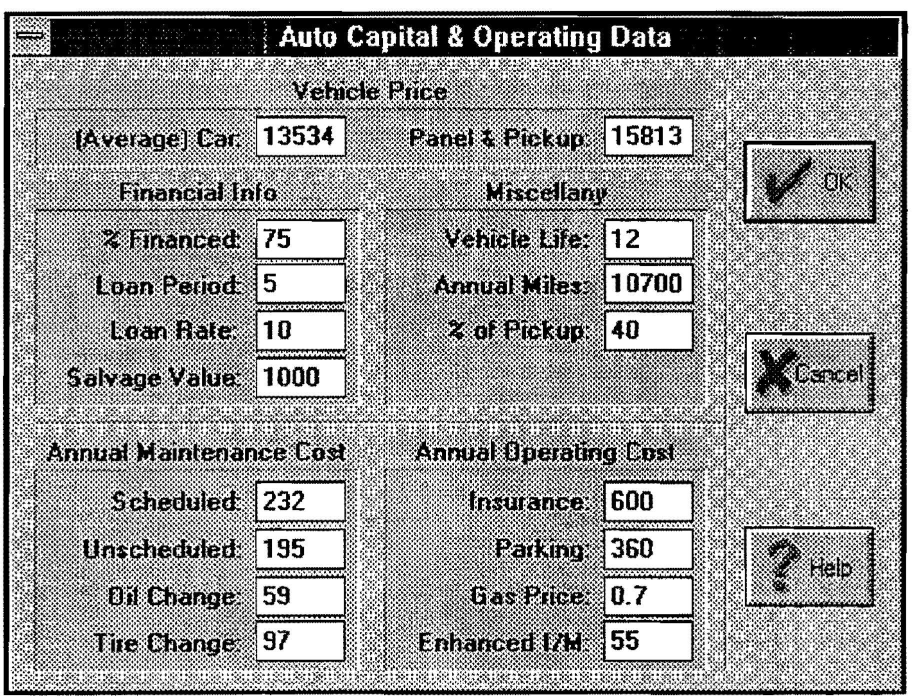

Figure D.6. Input Dialog Box 6 -- Auto Capital and Operating Data

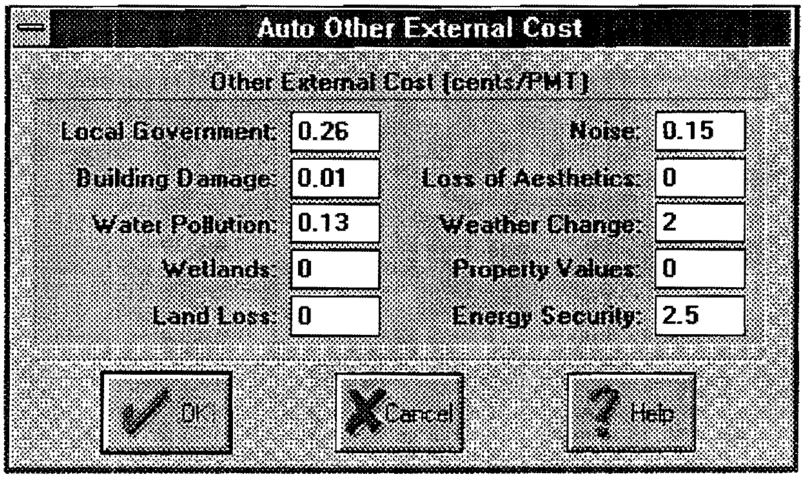

Figure D.7. Input Dialog Box 7 -- Auto External Data

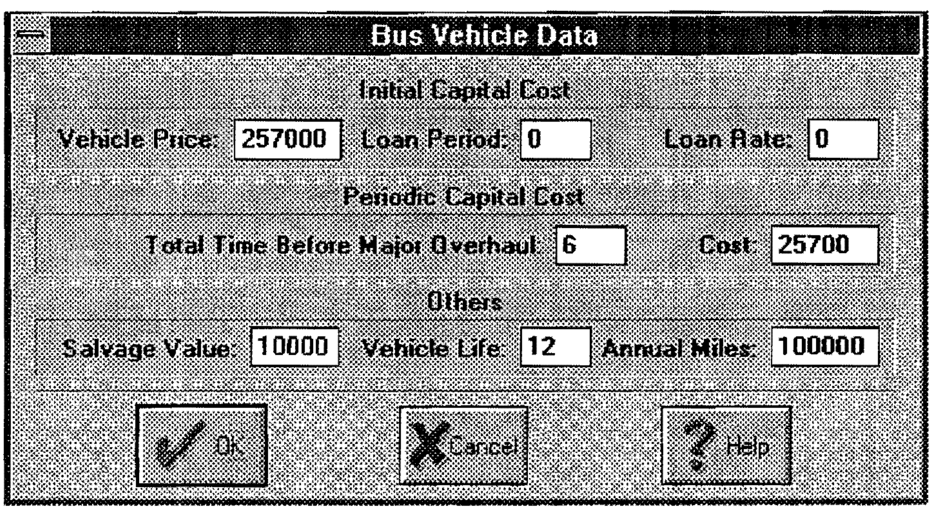

Figure D.8. Input Dialog Box 8 -- Bus Vehicle Data

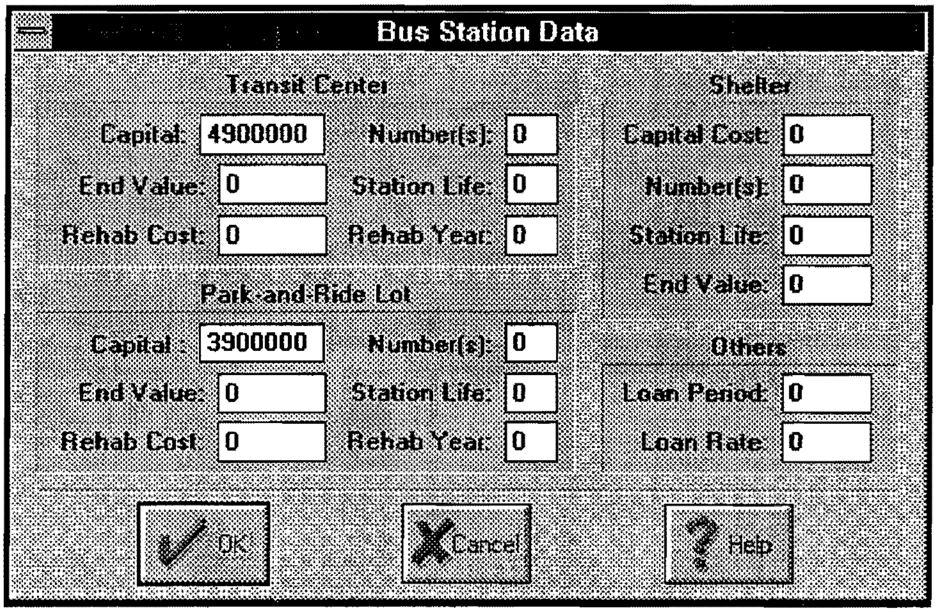

Figure D.9. Input Dialog Box 9 -- Bus Station Data

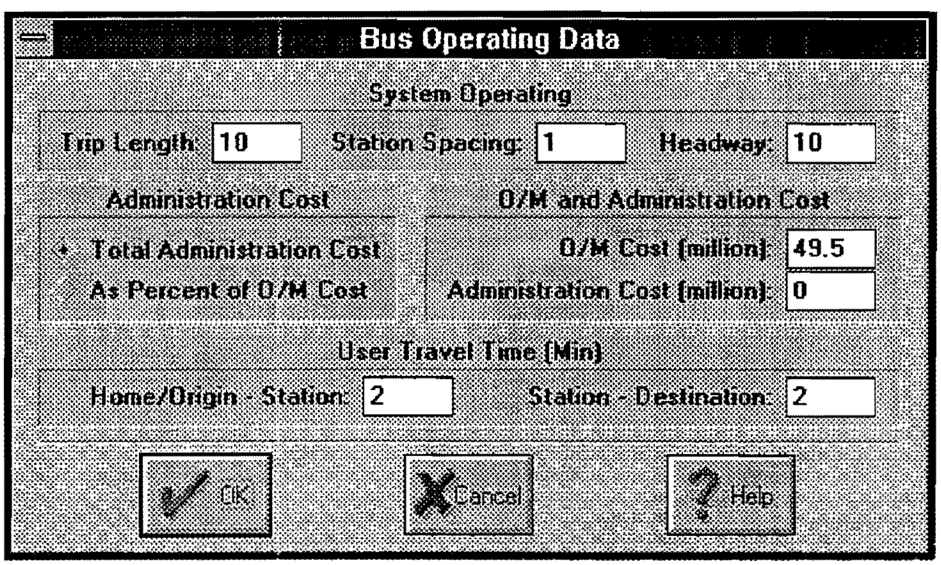

Figure D.10. Input Dialog Box 10 -- Bus Operating Data

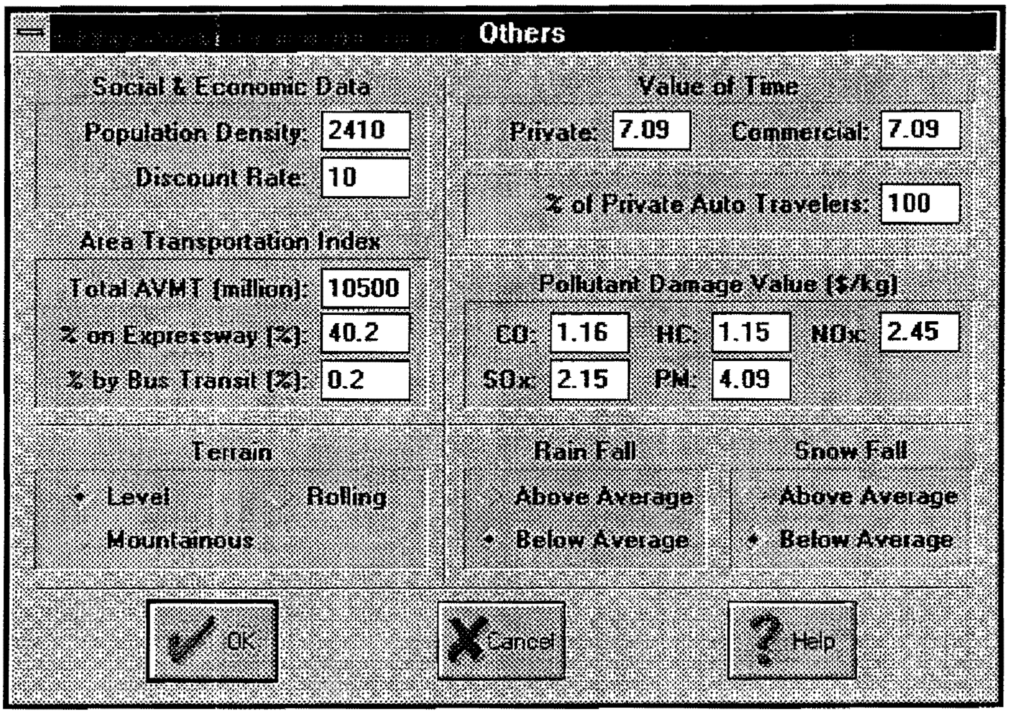

Figure D.11. Input Dialog Box 11 -- Other Data

OUTPUT (C:\JIEFENG\SA\SA1_3.OUT)

1. Auto and/or Bus

Roadway Section (Main Lane):

Annual Cost (in $/yr) by Modes

Mode	Auto & Pickup	Bus	Truck	Total
Facility Cost	1,357,815	53,765	1,032,292	2,443,872
Travel Time Cost	154,227,152	1,363,939	20,678,460	176,269,552
Air Pollution Cost	7,122,664	8,106	1,533,710	8,664,480
Incident Delay Cost	4,336,406	34,971	581,349	4,952,726
Accident Cost	1,133,764	0	182,394	1,316,158
Other External Cost	7,075,810	21,469	948,601	8,045,880
User/Agency Cost	44,609,696	361,448	0	44,971,144

Highway Facility Cost

	Annual Cost ($/yr)	Initial Lump-Sum ($)
Right-of-way	0	0
Cost of Preparing Roadway-Bed	63,851	601,920
Shoulder, Sewer, Signage, Lighting	870,698	8,208,000
Cost of Interchange/Intersection	759,527	7,160,000
Pavement Cost	197,745	1,864,122
Rehabilitation Cost	78,164	-
Annual Maintenance Cost	136,800	-
Cost of Administration, Safety, etc.	337,086	-

Travel Time Cost (in $/yr) of Different Periods (Unit Cost: $/PMT)

Period (Direction)	Auto & Pickup	Bus	Truck
Weekday AM Peak (1)	13,453,163 (2.199)	113,105 (2.292)	1,803,815 (2.199)
Weekday PM Peak (1)	13,453,163 (2.199)	113,105 (2.292)	1,803,815 (2.199)
Weekday Day (1)	46,783,644 (1.033)	411,416 (1.127)	6,272,803 (1.033)
Weekday Night (1)	360,566 (0.098)	5,675 (0.192)	48,345 (0.098)
Weekend AM Peak (1)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend PM Peak (1)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend Day (1)	2,954,542 (0.170)	36,955 (0.263)	395,911 (0.170)
Weekend Night (1)	108,507 (0.098)	1,713 (0.191)	14,540 (0.098)
Weekday AM Peak (2)	13,453,163 (2.199)	113,105 (2.292)	1,803,815 (2.199)
Weekday PM Peak (2)	13,453,163 (2.199)	113,105 (2.292)	1,803,815 (2.199)
Weekday Day (2)	46,783,644 (1.033)	411,416 (1.127)	6,272,803 (1.033)
Weekday Night (2)	360,566 (0.098)	5,675 (0.192)	48,345 (0.098)
Weekend AM Peak (2)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend PM Peak (2)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend Day (2)	2,954,542 (0.170)	36,955 (0.263)	395,911 (0.170)
Weekend Night (2)	108,507 (0.098)	1,713 (0.191)	14,540 (0.098)

Pollution Cost (in $/yr) of Different Periods (Unit Cost: $/PMT)

Period (Direction)	Auto & Pickup	Bus	Truck
Weekday AM Peak (1)	557,514 (0.091)	555 (0.011)	105,474 (0.129)
Weekday PM Peak (1)	557,514 (0.091)	555 (0.011)	105,474 (0.129)
Weekday Day (1)	2,126,376 (0.047)	2,164 (0.006)	400,797 (0.066)
Weekday Night (1)	67,328 (0.018)	121 (0.004)	29,453 (0.060)
Weekend AM Peak (1)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend PM Peak (1)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend Day (1)	231,742 (0.013)	621 (0.004)	116,651 (0.050)
Weekend Night (1)	20,857 (0.019)	37 (0.004)	9,007 (0.060)
Weekday AM Peak (2)	557,514 (0.091)	555 (0.011)	105,474 (0.129)
Weekday PM Peak (2)	557,514 (0.091)	555 (0.011)	105,474 (0.129)
Weekday Day (2)	2,126,376 (0.047)	2,164 (0.006)	400,797 (0.066)
Weekday Night (2)	67,328 (0.018)	121 (0.004)	29,453 (0.060)
Weekend AM Peak (2)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend PM Peak (2)	0 (0.000)	0 (0.000)	0 (0.000)
Weekend Day (2)	231,742 (0.013)	621 (0.004)	116,651 (0.050)
Weekend Night (2)	20,857 (0.019)	37 (0.004)	9,007 (0.060)

Cost (million $) by year and by categories: Auto Main Lane

Year	Facility	Time	Air Pollut	Inci Delay	Accident	External	User/Age
1	1.358	39.259	2.499	3.649	0.954	5.954	37.539
2	1.358	41.868	2.601	3.722	0.973	6.073	38.290
3	1.358	44.605	2.708	3.797	0.993	6.195	39.056
4	1.358	47.474	2.820	3.872	1.012	6.319	39.837
5	1.358	50.482	2.938	3.950	1.033	6.445	40.634
6	1.358	53.636	3.060	4.029	1.053	6.574	41.447
7	1.358	56.940	3.189	4.109	1.074	6.706	42.275
8	1.358	60.403	3.323	4.192	1.096	6.840	43.121
9	1.358	64.031	3.463	4.276	1.118	6.976	43.983
10	1.358	67.832	3.610	4.361	1.140	7.116	44.863
11	1.358	71.814	3.764	4.448	1.163	7.258	45.760
12	1.358	75.984	3.925	4.537	1.186	7.403	46.675
13	1.358	80.353	4.093	4.628	1.210	7.552	47.609
14	1.358	84.927	4.269	4.721	1.234	7.703	48.561
15	1.358	89.718	4.453	4.815	1.259	7.857	49.532
16	1.358	94.735	4.646	4.911	1.284	8.014	50.523
17	1.358	99.988	4.847	5.009	1.310	8.174	51.534
18	1.358	115.208	5.377	5.110	1.336	8.338	52.564
19	1.358	216.021	9.535	5.212	1.363	8.504	53.615
20	1.358	322.829	13.701	5.316	1.390	8.674	54.688
21	1.358	435.917	18.252	5.422	1.418	8.848	55.782
22	1.358	555.574	23.133	5.531	1.446	9.025	56.897
23	1.358	682.109	28.329	5.641	1.475	9.205	58.035
24	1.358	815.840	33.843	5.754	1.504	9.389	59.196
25	1.358	957.098	39.681	5.869	1.535	9.577	60.380
26	1.358	1106.232	45.854	5.987	1.565	9.769	61.587
27	1.358	1263.604	52.377	6.106	1.597	9.964	62.819
28	1.358	1473.778	61.067	6.229	1.628	10.163	64.075
29	1.358	1701.299	70.377	6.353	1.661	10.367	65.357
30	1.358	1941.372	80.284	6.480	1.694	10.574	66.664

Cost (million $) by year and by categories: Auto HOV Lane

Year	Facility	Time	Air Pollut	Inci Delay	Accident	External	User/Age
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Cost (million $) by year and by categories: Bus Main Lane

Year	Facility	Time	Air Pollut	Inci Delay	Accident	External	User/Age
1	0.054	0.418	0.006	0.029	0.000	0.018	0.304
2	0.054	0.441	0.006	0.030	0.000	0.018	0.310
3	0.054	0.465	0.006	0.031	0.000	0.019	0.316
4	0.054	0.490	0.006	0.031	0.000	0.019	0.323
5	0.054	0.517	0.006	0.032	0.000	0.020	0.329
6	0.054	0.544	0.006	0.032	0.000	0.020	0.336
7	0.054	0.573	0.006	0.033	0.000	0.020	0.343
8	0.054	0.603	0.007	0.034	0.000	0.021	0.349
9	0.054	0.635	0.007	0.034	0.000	0.021	0.356
10	0.054	0.668	0.007	0.035	0.000	0.022	0.364
11	0.054	0.702	0.007	0.036	0.000	0.022	0.371
12	0.054	0.739	0.007	0.037	0.000	0.022	0.378
13	0.054	0.776	0.007	0.037	0.000	0.023	0.386
14	0.054	0.816	0.008	0.038	0.000	0.023	0.393
15	0.054	0.857	0.008	0.039	0.000	0.024	0.401
16	0.054	0.900	0.008	0.040	0.000	0.024	0.409
17	0.054	0.945	0.008	0.040	0.000	0.025	0.418
18	0.054	1.071	0.009	0.041	0.000	0.025	0.426
19	0.054	1.887	0.013	0.042	0.000	0.026	0.434
20	0.054	2.751	0.015	0.043	0.000	0.026	0.443
21	0.054	3.666	0.016	0.044	0.000	0.027	0.452
22	0.054	4.634	0.017	0.045	0.000	0.027	0.461
23	0.054	5.657	0.018	0.045	0.000	0.028	0.470
24	0.054	6.739	0.019	0.046	0.000	0.028	0.480
25	0.054	7.881	0.020	0.047	0.000	0.029	0.489
26	0.054	9.087	0.022	0.048	0.000	0.030	0.499
27	0.054	10.360	0.023	0.049	0.000	0.030	0.509
28	0.054	12.058	0.026	0.050	0.000	0.031	0.519
29	0.054	13.896	0.028	0.051	0.000	0.031	0.530
30	0.054	15.836	0.030	0.052	0.000	0.032	0.540

Cost (million $) by year and by categories: Bus HOV Lane

Year	Facility	Time	Air Pollut	Inci Delay	Accident	External	User/Age
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000

Cost (million $) by year and by categories: Rail

Year	Facility	Time	Air Pollut	Inci Delay	Accident	External	User/Age
1	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.000	0.000	0.000	0.000	0.000	0.000	0.000
3	0.000	0.000	0.000	0.000	0.000	0.000	0.000
4	0.000	0.000	0.000	0.000	0.000	0.000	0.000
5	0.000	0.000	0.000	0.000	0.000	0.000	0.000
6	0.000	0.000	0.000	0.000	0.000	0.000	0.000
7	0.000	0.000	0.000	0.000	0.000	0.000	0.000
8	0.000	0.000	0.000	0.000	0.000	0.000	0.000
9	0.000	0.000	0.000	0.000	0.000	0.000	0.000
10	0.000	0.000	0.000	0.000	0.000	0.000	0.000
11	0.000	0.000	0.000	0.000	0.000	0.000	0.000
12	0.000	0.000	0.000	0.000	0.000	0.000	0.000
13	0.000	0.000	0.000	0.000	0.000	0.000	0.000
14	0.000	0.000	0.000	0.000	0.000	0.000	0.000
15	0.000	0.000	0.000	0.000	0.000	0.000	0.000
16	0.000	0.000	0.000	0.000	0.000	0.000	0.000
17	0.000	0.000	0.000	0.000	0.000	0.000	0.000
18	0.000	0.000	0.000	0.000	0.000	0.000	0.000
19	0.000	0.000	0.000	0.000	0.000	0.000	0.000
20	0.000	0.000	0.000	0.000	0.000	0.000	0.000
21	0.000	0.000	0.000	0.000	0.000	0.000	0.000
22	0.000	0.000	0.000	0.000	0.000	0.000	0.000
23	0.000	0.000	0.000	0.000	0.000	0.000	0.000
24	0.000	0.000	0.000	0.000	0.000	0.000	0.000
25	0.000	0.000	0.000	0.000	0.000	0.000	0.000
26	0.000	0.000	0.000	0.000	0.000	0.000	0.000
27	0.000	0.000	0.000	0.000	0.000	0.000	0.000
28	0.000	0.000	0.000	0.000	0.000	0.000	0.000
29	0.000	0.000	0.000	0.000	0.000	0.000	0.000
30	0.000	0.000	0.000	0.000	0.000	0.000	0.000