TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
FHWA/TX-93/1229-1F		

4. Title and Subtitle	5. Report Date
Evaluation of Upgrade to Standards Requirements for FM Highways in Texas	November 1992
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Jeffery L. Memmott and James W. Hanks, Jr.	Research Report 1229-1F
9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute Texas A&M University System College Station, Texas 77843-3135	11. Contract or Grant No. Study No. 2-8-91/2-1229
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
Texas Department of Transportation, Transportation Planning Division P.O. Box 5051, Austin, Texas 78763	Final - Sep. 90 to Aug. 92
	14. Sponsoring Agency Code

15. Supplementary Notes

Research performed in cooperation with DOT, FHWA.
Research Study Title: The Costs and Effectiveness of Upgrade to Standards as Part of the TxDOT Rehabilitation Program

16. Abstract

This report covers an evaluation of the upgrade to standards requirements for FM highways in Texas. The objectives of the study were to determine the additional costs of upgrade to standards requirements as part of the TxDOT Rehabilitation Program, develop alternative strategies and policies to reduce those adverse impacts, and evaluate the cost-effectiveness of proposed strategies for upgrading substandard highways. The first section of the report covers the literature review, survey of districts, and design exceptions. The second section covers the estimated costs, both to TxDOT and to motorists, of not upgrading a representative 2-lane FM highway. The third section covers the use of the HEEM-III program to make estimates of the cost-effectiveness of upgrading these substandard highways. The last section covers possible policy alternatives and implications.

The results from the cost-effectiveness analysis clearly show that it is not cost-effective to require full resurfacing, restoration, or rehabilitation (RRR) design standards for all low-volume rural roads. As the ADT goes up, higher standards become more cost-effective. Given the results in the report, a minimal rehabilitation strategy is most cost-effective between 500 and 1500 ADT, a partial upgrade strategy between 1500 and 2000 ADT, and a full upgrade strategy for ADT 2000 and above. While cost-effectiveness should not be the only criteria for setting design standards, the results would seem to justify some modification of the RRR design standards to take into account the potential benefits as compared to the additional costs.

The report also outlines several possible short-run and long-run alternatives to reduce the current problems associated with rehabilitating substandard FM highways. The most promising alternative is to give TxDOT authority to participate with matching funds for ROW acquisition along FM highways.

17. Key Words	18. Distribution Statement
Upgrade to Standards, RRR Program, Cost-Effectiveness, Pavement Rehabilitation	No Restrictions. This document is available to the public through the National Information Service, 5285 Port Royal Road, Springfield, Virginia 22161

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price
Unclassified	Unclassified	110	

Form DOT F 1700.7 (8-69)

EVALUATION OF UPGRADE TO STANDARDS REQUIREMENTS FOR FM HIGHWAYS IN TEXAS

by

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Research Report 1229-1F
Research Study Number 2-8-91/2-1229
The Costs and Effectiveness of Upgrade to Standards
as Part of the TxDOT Rehabilitation Program

Sponsored by

Texas Department of Transportation

in cooperation with

U.S. Department of Transportation
Federal Highway Administration

November 1992

METRIC (SI*) CONVERSION FACTORS

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
in	inches	2.54	centimetres	cm
ft	feet	0.3048	metres	m
yd	yards	0.914	metres	m
mi	miles	1.61	kilometres	km
AREA				
in^2	square inches	645.2	centimetres squared	cm^2
ft^2	square feet	0.0929	metres squared	m^2
yd^2	square yards	0.836	metres squared	m^2
mi^2	square miles	2.59	kilometres squared	km^2
ac	acres	0.395	hectares	ha
MASS (weight)				
oz	ounces	28.35	grams	g
lb	pounds	0.454	kilograms	kg
T	short tons (2000 lb)	0.907	megagrams	Mg
VOLUME				
fl oz	fluid ounces	29.57	millilitres	mL
gal	gallons	3.785	litres	L
ft^3	cubic feet	0.0328	metres cubed	m^3
yd^3	cubic yards	0.0765	metres cubed	m^3

NOTE: Volumes greater than 1000 L shall be shown in m^3.

TEMPERATURE (exact)

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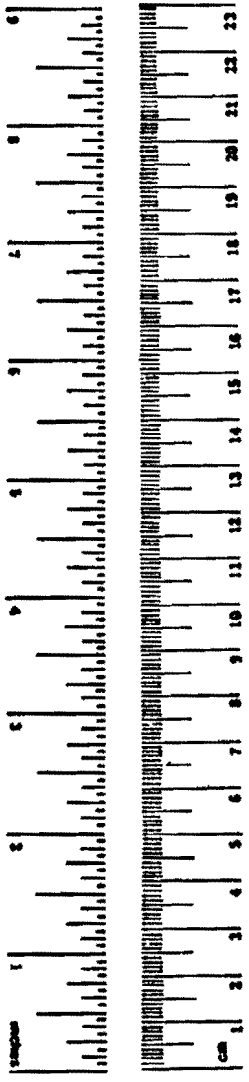

APPROXIMATE CONVERSIONS TO SI UNITS

Symbol	When You Know	Multiply By	To Find	Symbol
LENGTH				
mm	millimetres	0.039	inches	in
m	metres	3.28	feet	ft
m	metres	1.09	yards	yd
km	kilometres	0.621	miles	mi
AREA				
mm^2	millimetres squared	0.0016	square inches	in^2
m^2	metres squared	10.764	square feet	ft^2
km^2	kilometres squared	0.39	square miles	mi^2
ha	hectares (10 000 m^2)	2.53	acres	ac
MASS (weight)				
g	grams	0.0353	ounces	oz
kg	kilograms	2.205	pounds	lb
Mg	megagrams (1 000 kg)	1.103	short tons	T
VOLUME				
mL	millilitres	0.034	fluid ounces	fl oz
L	litres	0.264	gallons	gal
m^3	metres cubed	35.315	cubic feet	ft^3
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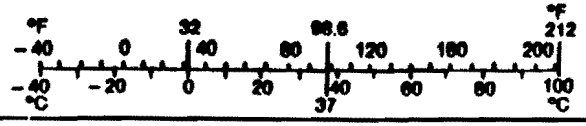

These factors conform to the requirement of FHWA Order 5190.1A.

* SI is the symbol for the International System of Measurements

ABSTRACT

This report covers an evaluation of the upgrade to standards requirements for FM highways in Texas. The objectives of the study were to determine the additional costs of upgrade to standards requirements as part of the TxDOT Rehabilitation Program, develop alternative strategies and policies to reduce those adverse impacts, and evaluate the cost-effectiveness of proposed strategies for upgrading substandard highways. The first section of the report covers the literature review, survey of districts, and design exceptions. The second section covers the estimated costs, both to TxDOT and to motorists, of not upgrading a representative 2-lane FM highway. The third section covers the use of the HEEM-III program to make estimates of the cost-effectiveness of upgrading these substandard highways. The last section covers possible policy alternatives and implications.

The results from the cost-effectiveness analysis clearly show that it is not cost-effective to require full resurfacing, restoration, or rehabilitation (RRR) design standards for all low-volume rural roads. As the ADT goes up, higher standards become more cost-effective. Given the results in the report, a minimal rehabilitation strategy is most cost-effective between 500 and 1500 ADT, a partial upgrade strategy between 1500 and 2000 ADT, and a full upgrade strategy for ADT 2000 and above. While cost-effectiveness should not be the only criteria for setting design standards, the results would seem to justify some modification of the RRR design standards to take into account the potential benefits as compared to the additional costs.

The report also outlines several possible short-run and long-run alternatives to reduce the current problems associated with rehabilitating substandard FM highways. The most promising alternative is to give TxDOT authority to participate with matching funds for ROW acquisition along FM highways.

ACKNOWLEDGEMENT

The authors wish to thank Billy Rogers, Robert Wilson, William Garbade, Tom Word, James R. Evans, and J. L. Beaird for their helpful comments, information, and suggestions during the course of the research project. Special appreciation is due to Richard J. Skopik for the extensive information provided on the case studies and help with the design exception process.

DISCLAIMER STATEMENT

The contents of this report reflect the views of the authors and do not necessarily reflect the official views or policies of the Federal Highway Administration or the Texas State Department of Highways and Public Transportation. This report does not constitute a standard, a specification, or a regulation, nor is it intended for construction, bidding, or permit purposes.

SUMMARY

When the Farm-to-Market (FM) system was originally built in Texas, some districts tried to conserve resources and/or build as much mileage as possible by using the minimum right-of-way (ROW) and highway surface. That resulted in many FM miles with deficiencies by today's standards, with narrow ROW and narrow road surface. A somewhat similar problem exists for many 4-lane highways without paved shoulders, "poor-boy highways", not enough ROW to rehabilitate without having to upgrade. These substandard roads constitute a significant problem in some districts. In District 14, of the 3000 total miles in the district, about 1000 miles are substandard 2-lane highways, and another 500 miles are substandard 4-lane highways.

The problem now is that in order to rehabilitate these highways, they must be upgraded, which requires acquiring additional ROW. However, the cities or counties must purchase the ROW. There is little incentive for them to do that since they already purchased the ROW when the highways were built, and the roads are still in service and carrying traffic.

This lack of ROW to do rehabilitation results in spending extra money from the preventative maintenance budget to keep these highways in service. District personnel are continually required to go out and do maintenance work on a pavement that is in very poor condition.

The cost of improving roadways constructed up to 40 years ago, mostly two-lane FM and some four-lane highways, to current design criteria has become a substantial burden on District construction and maintenance budgets. In most cases, these roadways were constructed to meet or exceed design standards and accepted practices of that time period. Today, however, these designs are considered substandard by current Federal and State design criteria. Therefore, prior to utilizing funds marked for rehabilitation, these roadways must be redesigned to meet the present design standards.

It is clear from the estimates made in this study that it is not cost-effective to require full RRR design standards for all low-volume rural roads. As the ADT goes up, higher standards become more cost-effective. Given the results in the report, a minimal

rehabilitation strategy is most cost-effective between 500 and 1500 ADT, a partial upgrade strategy between 1500 and 2000 ADT, and a full upgrade strategy for ADT 2000 and above. While cost-effectiveness should not be the only criteria for setting design standards, the results would seem to justify some modification of the RRR design standards to take into account the potential benefits as compared to the additional costs.

A methodology is also presented to make cost-effectiveness estimates of rehabilitation strategies using the HEEM-III computer program. The data requirements are discussed, along with a discussion of the use of the program.

Several alternatives are discussed as possible methods to reduce the problem of rehabilitating substandard FM highways.

Possible Short-Term Alternatives:

1. Provide Design Exception Guidelines.
2. Restructure Design Exception Review Process.
3. Modify Design Standards.

Possible Long-Term Alternatives:

1. Allow State Participation for FM ROW Acquisition.
2. Legislature Provide Funds for ROW Acquisition.
3. Use Local Option Highway Improvement Funds.

Of the alternatives presented above, the one that seems to have the greatest likelihood of success is for TxDOT to be given authority to participate in FM ROW acquisition through a matching money program similar to existing programs for other highway classes. This would give the districts the flexibility to make the tradeoffs between rehabilitation and continued use of maintenance money on these substandard FM highways.

TABLE OF CONTENTS

LIST OF TABLES

LIST OF FIGURES

INTRODUCTION

When the Farm-to Market (FM) system was originally built in Texas, some districts tried to conserve resources and/or build as much mileage as possible by using the minimum right-of way (ROW) and highway surface possible. That resulted in many FM miles with deficiencies by today's standards—narrow ROW and narrow road surface. A somewhat similar problem exists for many 4-lane highways without paved shoulders, "poorboy highways", not enough ROW to rehabilitate without having to upgrade. These substandard roads constitute a significant problem in some districts. In District 14, of the 3000 total miles in the district, about 1000 miles are substandard 2-lane highways and another 500 miles are substandard 4-lane highways.

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A few years ago, TxDOT conducted a survey of the districts to determine the extent of substandard 2-lane highways in Texas. A summary is given in Table 1. As can be seen, several districts have substantial miles of substandard highways.

Table 1. Substandard Width 2-Lane Highways in Texas

District	Mileage with ADT>400	
	ADT 400-750	ADT +750
1	505	408
2	305	361
3	318	391
4	114	66
5	548	183
6	93	50
7	129	28
8	320	165
9	283	167
10	641	1,039
11	596	721
12	59	519
13	340	497
14	488	531
15	309	344
16	267	232
17	485	760
18	245	494
19	521	599
20	208	645
21	344	414
23	120	102
24		
25		
Total	7,235	8,718

Currently it is very difficult to get FHWA approval for construction or reconstruction of a federal aid project without also meeting the minimum design standards for that facility. These standards cover such things as minimum lane and shoulder widths, bridge width, horizontal curvature and superelevation, vertical curvature and stopping sight distance, and sideslopes and clear zones. Frequently, meeting these design standards requires acquiring additional right-of-way. However the ROW must be acquired by the local government unit, city or county. As mentioned above, many times they are reluctant to spend the money for the ROW since they had to acquire the ROW when the road was originally built, and the road is still carrying traffic. For those highways that need to be rehabilitated, but cannot obtain additional ROW, maintenance money must be used to keep the road operational.

The upgrade requirements for the Rehabilitation Program in Texas are a positive step toward improving the highway system, especially in terms of improved safety. There are, however, some adverse consequences of those policies in some circumstances. The problem of obtaining additional ROW, the additional maintenance costs of deferred rehabilitation, and the most cost-effective upgrade strategies all need to be addressed, and are covered in this report.

One aspect of the upgrade requirements that has not received much attention in previous research is the effect on maintenance expenditures when the highway cannot be rehabilitated. This deferment of rehabilitation work results in additional current maintenance expenditures, as well as additional future expenses. A simple life-cycle cost estimation procedure has been developed for this situation, using the HEEM-III computer program [14], so the additional costs can be taken into account in the decision making process. The life-cycle cost procedure developed in this study generally relies on previous work on highway improvement evaluation, user costs, and pavements conducted in Texas.

The objectives of this study were to determine the additional costs of upgrade to standards requirements as part of the TxDOT Rehabilitation Program, develop alternative strategies and policies to reduce those adverse impacts, and evaluate the cost-effectiveness of proposed strategies for upgrading substandard highways. These

objectives are covered in the following sections of the report. The first section covers the literature review, survey of districts, and design exceptions. The second section covers the estimated costs, both to TxDOT and to motorists, of not upgrading a representative 2-lane FM highway. The third section covers the use of the HEEM-III program to make estimates of the cost-effectiveness of upgrading these substandard highways. The last section covers possible policy alternatives and implications.

LITERATURE REVIEW, SURVEY OF DISTRICTS, DESIGN EXCEPTIONS

When the initial construction of the Farm-to Market system in Texas began, cities and counties eagerly participated in the acquisition of the required right-of-way. In many instances minimum right-of way and roadway surface was used to conserve monetary resources and construct as many lane-miles as possible.

Currently, many of these facilities do not meet today's standards and are approaching the end of their service life. The lack of right-of-way prohibits or restricts much needed rehabilitation work under Texas Department of Transportation's resurfacing, restoration, or rehabilitation (RRR) construction projects. Even with special design guidelines developed for RRR projects, some situations are so restrictive that it is not feasible to meet the conditions of the RRR guidelines.

LITERATURE REVIEW

This section contains a brief discussion of the available literature on the cost, design recommendations, and effectiveness of upgrade to standard programs.

Safety Effects of Cross-Section Design for Two-Lane Roads - Vol. 1 - Final Report. C.V. Zeeger, J. Hummer, D. Reinfurt, L. Hurf, and W. Hunter. FHWA-RD-87/008

This study was conducted using rural two-lane roads from seven states. It was intended to quantify the cost/benefit relationship resulting from lane widening, shoulder widening, side slope flattening and roadside improvements. It concludes that lane and shoulder conditions directly affect run-off roads and opposite direction accidents. A cost model is developed to determine the cost effectiveness of different improvements on different roads.

Design in Rural Road Safety. John C. Glennon. American City and County, Jan. 1980, pp. 29-32.

This article gives suggestions about many different safety aspects of low-volume rural roads and the general cost-effectiveness of each. It states that speed-limit signs are important for keeping the driver aware of roadway conditions and safe speeds for traveling on these roads. Shoulders on roads are probably needed mainly for a design speed of 45 miles per hour or higher. The article gives suggestions on design speed and roadway width and horizontal curves and design speed. Stop signs generally cannot be justified at the intersection of two low-volume roads, and the cost-benefit balance of centerline markings would be at 300 ADT.

Guidelines for Using Wide-Paved Shoulders on Low-Volume Two-Lane Rural Highways Based on Benefit-Cost Analysis. TTI Research Report 1114-1F, D.L. Woods, J.B. Rollins, and L.M. Crane.

This is a study of the cost-effectiveness of wide-paved shoulders on two-lane rural highways. Six-foot shoulders were considered driveable, and it was recommended that a driveable shoulder be added to two-lane highways with an ADT of greater than 1500. This study includes a summary of edge and shoulder maintenance costs and a benefit/cost analysis of adding shoulders on two-lane highways.

Pavement Width Standards for Rural Two-Lane Highways. P. Shannon and A. Stanley, pp. 20-23.

This study was conducted on two-lane rural roads with ADT < 3000 in areas of Idaho and Washington. It makes a cost-effective comparison of ADT range, pavement width and accident rate. It shows graphs relating the year in which the savings due to accident reduction would repay the added costs of wider paved roads. Suggested minimum widths for current ADT are 20' for 0-399 ADT; 24' for 400-749 ADT; 28' for 750-999 ADT; 34' for 1000-1999 ADT; and 40' for 2000-2999 ADT.

Shoulder Improvements on Two-Lane Roads. David L. Davis, pp. 59-60.

This article shows graphs of different relationships between accident rates, shoulder widths and benefit/cost ratios. It concludes that the optimum shoulder widths for various traffic volumes and travel speeds were as follows: for speeds of 30 mph, 2' shoulders should be used for <1000 ADT; 6' for between 1000-5000 ADT; 8' for 5000-6000 ADT; and 10' for >6000 ADT. For 60 mph, 4' shoulders should be used for ADT <1000; 6' for 1000-2000 ADT; 8' for 2000-3000 ADT; and 10' for >3000 ADT.

Operational and Safety Effects of Driving on Paved Shoulders in Texas. TTI Report 265-2F. D.B. Fambro, D.S. Turner, and R.O. Rogness.

This study deals with the use of wide shoulders on Texas Highways. It has statistics of surveys taken by "average" motorists and law enforcement officers on the safety and legality of driving on paved shoulders to turning lanes or for letting a faster car pass. Both a comparative analysis and a before-after technique were used to determine the safety benefits associated with paved shoulders. Recommendations for efficiently utilizing and controlling paved shoulder usage are presented.

Effect of Lane and Shoulder Widths on Accident Reduction on Rural, Two-Lane Roads. Charles V. Zeeger, Robert C. Deen, and Jesse G. Mayes, Transportation Research Record 806.

This is a study of the effects of lane and shoulder widening of rural two-lane highways. The study omitted all non-uniform sections of road and used "comparative analysis" instead of a before and after research. It was determined that the only accidents expected to decrease with lane and shoulder widening would be run-off-road and opposite direction accidents. The analyses indicate that a greater reduction in accidents can be realized by lane widening than by shoulder widening. Very little benefit can be realized by widening a lane to more than 11 feet or shoulders to more than 9 feet.

Effect of Shoulder Width and Condition on Safety: A Critique of Current State of the Art. Charles V. Zeeger and David D. Perkins, Transportation Research Record 757, pp. 25-34.

This study is a critique of past research studies to determine the effect of shoulder width and condition on highway safety. The studies that showed accident rates higher or indifferent to increasing shoulder width proved generally to be more unreliable than those that showed a decrease in accident rate with an increase in shoulder width. Recommendations on shoulder width and conditions were made including 1) optimum shoulder widths are 6-9 feet, and 2) the best cost-effective candidate for shoulder widening is the rural two-lane road with shoulders <3 feet and six or more related accidents per mile per year.

Stopping Sight Distance Considerations at Crest Vertical Curves on Rural Two-Lane Highways on Texas. TTI Research Report 1125-1F. D.B. Fambro, T. Urbanik II, W.M. Hinshaw, J.W. Hanks Jr., M.S. Ross, C.H. Tan, and C.J. Pretorius.

This study groups the road type into two categories for analysis: two-lane with shoulders and two-lane without shoulders. It analyzes the frequency and percentage of limited stopping sight distance for both, but no relationship is found between accident rate and percent limited stopping sight distance, except that where there are intersections within the limited sight distance portions of crest vertical curves, there is a marked increase in accident rate. There is no definite relationship between available sight distance and operating speed on crest vertical curves.

Shoulder Upgrading Alternatives to Improve Operational Characteristics of Two-Lane Highways. D.S. Turner, P.O. Rogness, and D.B. Fambro.

This study is made to determine the percent usage of paved shoulders on rural Texas highways. Three types of roads were used: two-lane roads with no shoulders, two-lane roads with shoulders, and four-lane undivided highways with no shoulders (poor-

boy) highways. It determined that the benefits of full-width paved shoulders by increasing average speed and decreasing number of cars in platoons increase as the volume of traffic increases, but conversion to poor-boy highways has no operational effect unless volume reaches about 150 vehicles per hour.

Before-After Accident Analysis for Two Shoulder Upgrading Alternative. R.O. Rogness, D.B. Fambro, and D.S. Turner, Transportation Research Record 855, pp. 41-47.

This report studied the improvement of rural two-lane highways. This included the addition of paved shoulders or conversion of two-lane roadways with full-width paved shoulders into undivided four-lane roadways without shoulders. It concludes that the addition of full-width paved shoulders is effective in reducing the number of single-vehicle accidents that occur, and, at moderate volume, in decreasing both single and multi-vehicle accidents. Conversion of a paved shoulder to an additional travel lane should be considered only for ADT greater than 3000.

A Cost-Safety Comparison of Illinois Rehabilitation Design Policies. J.L. Sanford, E.D. Meyer, and H.A. Dameron, Transportation Research Record 1060, pp. 70-74.

This report evaluates how cost- and safety-effective 3-R improvements were on two-lane rural highways in Illinois. The roads that were chosen for the study were 2/3 widening and resurfacing and 1/3 just resurfacing. Non-intersection accident rates and mean severity rates showed statistically significant reductions from the before period to the after period. Costs for the 3-R projects in this study exceeded accident reduction savings, but there were many other benefits from the improvements that have to be taken into consideration. These are listed in the report.

Designing Safer Roads; Practices for Resurfacing, Restoration, and Rehabilitation. TRB Special Report 214.

This report was organized by a study committee to review current RRR design practices and analyze the cost and safety tradeoffs of geometric improvements to existing highways. The study committee has recommended a variety of practices that will increase the safety cost-effectiveness of RRR projects. Some recommendations include safety-conscious design process, design practices for key highway features, other design procedures and assumptions, planning and programming RRR projects, and safety research and training.

SURVEY OF AFFECTED DISTRICTS

During this research project, the districts most adversely affected by the upgrade to standards program were surveyed. The purpose of this survey was to determine the scope of the problem, solicit suggestions for improving the situation, and suggestions for candidate study sites. Four TxDOT districts were interviewed during this phase of the project: 1) District 10 (Tyler), 2) District 11 (Lufkin), 3) District 14 (Austin), and 4) District 19 (Atlanta).

All the districts surveyed cited restrictive right-of-way as the single largest problem faced in RRR projects. Under current guidelines, if additional right-of-way is acquired, the design must meet full design standards. As a result of these guidelines, much needed rehabilitation or safety work is not performed, instead heavy maintenance is performed to allow the facility to remain operational. Current TxDOT practices allow districts to apply for design exceptions.

DESIGN EXCEPTIONS

The purpose of the RRR program is to preserve and extend the service life, and enhance safety, of existing highways and streets on the state highway system. Guidelines are provided to determine when proposed projects fall under those guidelines and the minimum design standards the project must satisfy. If some design elements of the

highway do not meet those standards, they generally must be upgraded for the project to be approved.

When it is not feasible to meet the RRR standards for one or more design elements on a proposed project, a design exception may be necessary. Design elements requiring a design exception include:

- pavement design life,
- deficient bridge rails (high volume roadways),
- bridge structural capacity,
- lane width,
- shoulder width,
- bridge width.

Some deficiencies do not require a design exception approved by D-8, Highway Design Division. They can be handled with a design waiver, which the District authorizes. While design waivers are included in the project documentation, they do not require any further approval. Design elements requiring a design waiver include:

- deficient bridge rails (low volume roadways),
- design speed,
- obstruction clearance,
- metal beam guard fence length,
- turn lane width,
- parallel parking lane width.

While TxDOT does have a procedure for submitting a request for design exception, the districts generally view the process as complicated and cumbersome. Blank forms are provided to request a design exception. For some of the items on the form little guidance is given as to the amount of information to provide, where to obtain the information, or in what form the information should be presented. While each case is site specific, the lack of detailed guidelines on filling out the design exception request appears to contribute to misunderstandings between division and district personnel. The information required for requesting a design exception are listed below:

- What is the highway type (low volume two-lane highway, urban street, etc.) and the design element (lane width, structural capacity, etc.) which requires project specific evaluation in order to accomplish the rehabilitation project?
- What is the design guideline value given in Part III, of the Highway Design Division Operations and Procedures Manual?
- What is the design value of the existing roadway condition?
- What is the expected design value of the roadway condition after project completion?
- What length and percentage of the project is affected by the design element in question?
- What is the ADT and the character (truck %, recreational use, local traffic, etc.) of the traffic using the roadway?
- What is the accident history (type, severity, conditions, etc.) of the entire project and the specific locations affected by the proposed design element?
- What is the compatibility of the proposed design with adjacent sections of the roadway?
- What is the comparative cost of the given design guideline versus the proposed design element in terms of construction, right-of-way availability, project delay, environmental impacts, etc.?
- What factors have been considered in order to minimize any adverse safety or operational effects of this specific design element?
- What is the long term effect of using the design element selected in terms of capacity and level of service?
- If other design elements are also undergoing project specific evaluation, what is believed to be the cumulative effect of these design elements on the safety and operation of the proposed facility?

Within the TxDOT administration, design exceptions are evaluated in a "ladder" type fashion. The design exceptions are submitted to D-8. The request for an exception is initially received by a D-8 field area and reviewed by several engineers prior to being submitted for approval. Both the division and districts agree that a panel review would

improve the review process. The review panel would be made up of district personnel and various division personnel including: bridge, traffic, design, safety, and other disciplines required to adequately evaluate the request for a design exception.

Another area of concern by the districts is the apparent lack of consistency in the evaluation process. There seems to be little connection between the information provided for requesting the design exception and the probability of its approval. For example a request may be rejected, even though a previous similar request, with the same documentation, had been approved. Some of the problem is the very site specific nature of design exception requests. Also some of the problem may be due to lack of experience and exposure of district personnel to the process. It would be of benefit to give more detailed guidance to districts on the criteria to be used to approve a design exception for a specific project, the evaluation process itself, and any additional information, not required in the design exception request, that would expedite the evaluation or improve the chances of approval.

CASE STUDIES AND COSTS OF REHABILITATION STRATEGIES

One of the major objectives of the research study was to determine the additional costs of the upgrade to standards requirements that are part of the RRR program. This was to be done using a case study approach which looks at several substandard highway sections to determine the costs of using routine maintenance money to maintain these highway sections, and the savings to be derived from rehabilitation of these sections, both with and without the upgrade requirements. However, during the course of the study several problems arose which limited the usefulness of the case study sites in making cost and benefit estimates. These problems are described below. As a result the focus changed somewhat to one of using the case study sites to create a representative substandard highway section, in order to generalize the results, and give sensitivity results to key variables such as the average daily traffic (ADT) volume.

CASE STUDIES

As a result of the District interviews, twelve candidate sites were identified for possible use as case studies. These sites are on FM 1327, FM 1626, and FM 1826 in Travis County; RM 2147 in Burnet County; FM 2001 in Caldwell County; FM 2867 and SH 43 in Rusk County; FM 225 in Nacogdoches County; FM 62 in Polk County; FM 2243 in Williamson County; FM 842 in Angelina County; and FM 223 in San Jacinto County. Considerable effort was made during the study to collect a complete data set on each of these case study sites. These data items included paved surface width, shoulder width, ROW width, ADT, pavement condition, horizontal and vertical alignment, accidents, and cost data.

One of the critical aspects of the case studies was to identify substandard geometric features and relate those to accident rates. The reason for this was due to the critical role these features are assumed to play in increased danger to motorists and the potential TxDOT liability of not correcting those deficiencies. However, during the course of the study, results of TTI Research Study 1125 became available. This study was not

able to establish any statistical correlation between high accident locations and highway geometrics, specifically as related to crest vertical curves. The lack of correlation was attributed to imprecise locations of accidents on written accident reports. This lack of accident rates tied to specific geometric features considerably reduced the value of the case studies for making estimates of the cost-effectiveness of the RRR design standards.

As a result, the case study data was used to create a representative substandard highway section which can easily be used to make aggregate cost and benefit estimates of various rehabilitation and upgrade strategies. The representative section can also be used to determine the cost-effectiveness of each strategy as they relate to the ADT.

REHABILITATION AND UPGRADE STRATEGIES

Four different maintenance, rehabilitation, and upgrade strategies are examined to determine the impacts on motorists and TxDOT over a twenty year analysis period. These strategies are:

1. Continue to heavily use routine maintenance money to keep the highway in service. No pavement rehabilitation or upgrade work is done over the analysis period.
2. Minimal pavement rehabilitation, with no upgrade of substandard geometrics, is performed at the beginning of the analysis period and is maintained with routine maintenance through the analysis period.
3. Pavement rehabilitation, with upgrade of some substandard geometrics, is performed at the beginning of the analysis period and maintained with routine maintenance through the analysis period.
4. Pavement rehabilitation and upgrade to RRR design standards, is performed at the beginning of the analysis period and is maintained with routine maintenance through the analysis period.

Table 2 lists some of the major assumptions and data for each of these strategies, which can be used in the cost-effectiveness estimates of the next subsection.

Table 2. Description of Rehabilitation Strategies

Category	Rehabilitation Strategies			
	Maint. Only	Minimal Rehab	Rehab w/ some Upgrd	Rehab w/ Full Upgrd
Number of Lanes	2	2	2	2
Length (miles)	1.00	1.00	1.00	1.00
Pavement Width (feet)	20	20	28	44
Forecasted ADT Multiple	1.5	1.5	1.5	1.5
Percent Trucks	11	11	11	11
Capacity (vplph)	743	743	842	991
Av. Free Flow Spd (mph)	45	45	50	55
Accident Adjust. Factor	9.99	9.99	5.00	1.00
Pav. Condition (PSI)	2.10	2.90	3.10	3.10
Ann. Routine Maint. Cost	4,860	520	260	260
Construction/ROW Cost	0	80,000	230,000	370,000

Each strategy assumes a 2 lane highway, one mile long. The pavement width varies from 20 feet for an existing substandard highway to 44 feet for a full upgrade. The twenty-year forecasted ADT is assumed to be 1.5 times the current ADT. The percent trucks is 11 percent, the approximate average for rural highways in Texas. The capacity is calculated using the adjustment tables in the next section of the report describing the

HEEM-III computer program [14]. These capacity adjustments are taken from the 1985 Highway Capacity Manual [15]. The average free flow speeds are estimated using one substandard curve of 30 mph on the first two strategies, and 40 mph on the third strategy.

The accident adjustment factors are more difficult to define and are assumed for this analysis, since precise data are not available on the impacts of substandard geometrics on accidents. These adjustments were intentionally made relatively large to be sure any safety benefits of upgrade standards would be captured. The pavement condition values are derived from data on the condition of Texas highways in Highway Statistics [16]. The annual routine maintenance costs and the construction/ROW costs are derived from various previous work at TTI, and the case study data, with some supplemental information from the Districts.

ESTIMATES OF COST-EFFECTIVENESS

To make estimates of the cost-effectiveness of the four strategies described above, the HEEM-III [14] PC computer program is used. It was developed by TTI for TxDOT in Research Study 1128. HEEM-III is the only PC program currently available in the world which can make estimates of the impacts of pavement rehabilitation in a comprehensive motorist benefit-cost framework. It is an extremely useful tool for this study, and the use of the program is described in the next section.

Tables 3 through 5 gives the summary estimates of both changes in motorist user costs and agency costs resulting from going from strategy one, maintenance only, to each of the other three rehabilitation and upgrade strategies. The benefits and costs are estimated over a twenty year analysis period using an eight percent discount rate. The cost effectiveness can be determined by looking at the net present value, which should be positive, and the benefit-cost ratio, which should be greater than one.

Table 3 gives the results of the comparison of the maintenance only strategy to the minimal rehabilitation strategy. The minimal rehabilitation strategy begins to be cost-effective at between 500 and 750 ADT.

Table 3. Comparison of Maintenance Only to Minimal Rehabilitation

Benefits and Costs	Current ADT							
	250	500	750	1000	1500	2000	2500	3000
Total Motorist User Benefits (millions $)	0.02	0.04	0.05	0.07	0.11	0.15	0.18	0.22
Reduction in Maint. Costs (millions $)	0.04	0.04	0.04	0.04	0.04	0.04	0.04	0.04
Construction Costs (millions $)	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Net Present Value (millions $)	-0.02	0.00	0.02	0.03	0.07	0.11	0.15	0.19
Benefit-Cost Ratio	0.76	0.98	1.20	1.43	1.89	2.36	2.84	3.32

Table 4 gives the results of the comparison of the maintenance only strategy to the rehabilitation with partial upgrade strategy. The partial upgrade strategy begins to be cost-effective at about 1000 ADT.

Table 4. Comparison of Maintenance Only to Rehabilitation with Partial Upgrade

Benefits and Costs	Current ADT							
	250	500	750	1000	1500	2000	2500	3000
Total Motorist User Benefits (millions $)	0.05	0.10	0.15	0.20	0.30	0.40	0.50	0.61
Reduction in Maint. Costs (millions $)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Construction Costs (millions $)	0.23	0.23	0.23	0.23	0.23	0.23	0.23	0.23
Net Present Value (millions $)	-0.14	-0.09	-0.04	0.01	0.11	0.21	0.32	0.43
Benefit-Cost Ratio	0.41	0.62	0.84	1.05	1.49	1.93	2.39	2.85

Table 5 gives the results of the comparison of the maintenance only strategy to the rehabilitation with full upgrade strategy. The full upgrade strategy begins to be cost-effective at about 1500 ADT.

Table 5. Comparison of Maintenance Only to Rehabilitation with Full Upgrade

Benefits and Costs	Current ADT							
	250	500	750	1000	1500	2000	2500	3000
Total Motorist User Benefits (millions $)	0.07	0.13	0.20	0.27	0.40	0.54	0.69	0.84
Reduction in Maint. Costs (millions $)	0.05	0.05	0.05	0.05	0.05	0.05	0.05	0.05
Construction Costs (millions $)	0.37	0.37	0.37	0.37	0.37	0.37	0.37	0.37
Net Present Value (millions $)	-0.26	-0.19	-0.13	-0.06	0.08	0.22	0.36	0.51
Benefit-Cost Ratio	0.30	0.48	0.66	0.84	1.21	1.59	1.98	2.38

Figure 1 gives the cost-effectiveness of the full upgrade rehabilitation strategy in graphical form. Each one of the curves on the graph represent a different construction cost per mile. On the vertical axis is the benefit-cost ratio, and on the horizontal axis is the ADT. This figure can be used to quickly determine at what point a proposed project would become cost effective to upgrade to full standards, when compared to a maintenance only strategy.

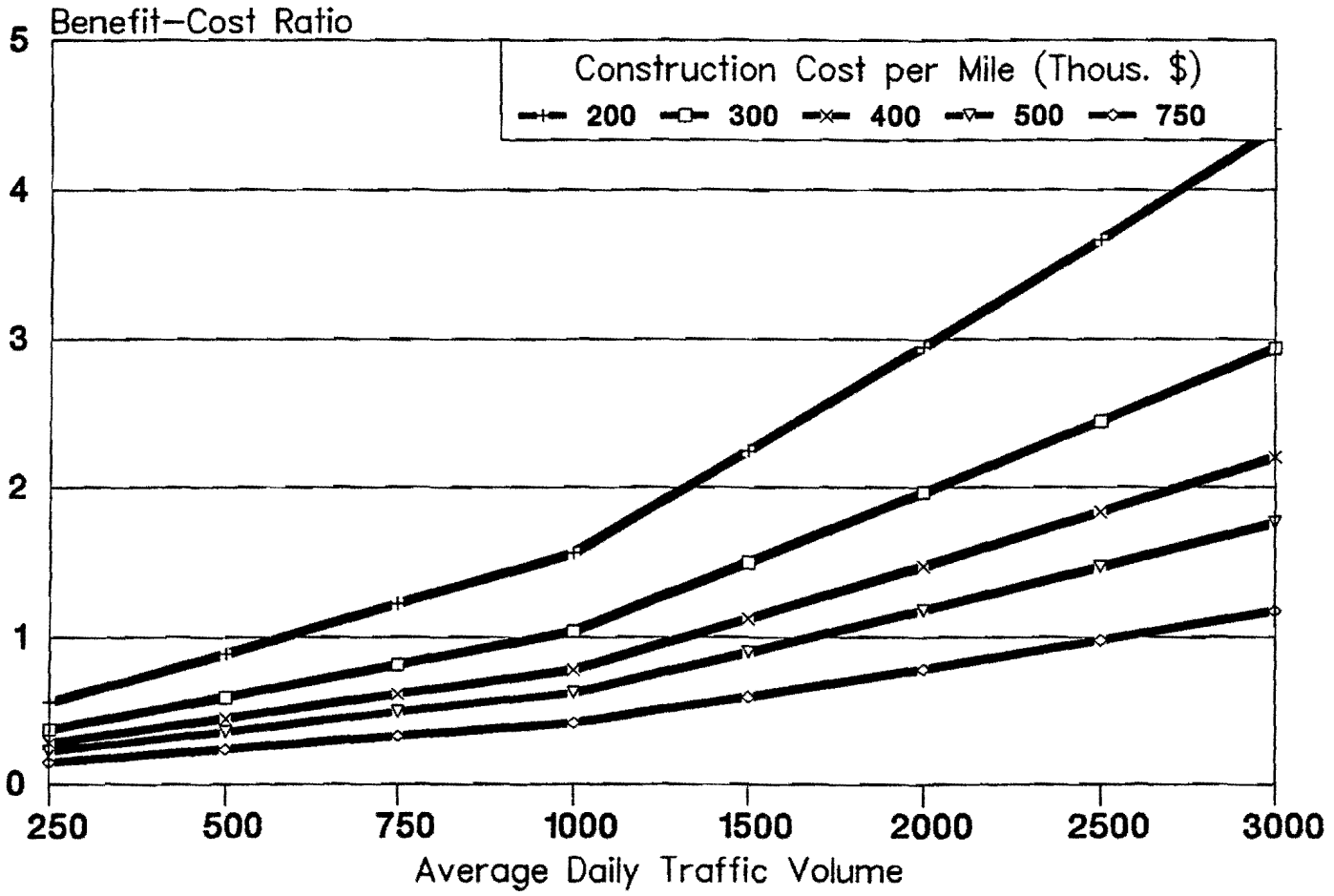

Figure 1. Cost-Effectiveness of Rehabilitation with Full Upgrade to Standards when compared to Maintenance Only Strategy

Incremental Benefits and Costs

Another way of looking at the cost-effectiveness of the various rehabilitation strategies is to look at the incremental benefits of each strategy as compared to the incremental cost. The incremental benefit-cost ratio is commonly used for project prioritization and selection with a budget constraint, when there is not enough money to fund all desirable projects.

The incremental benefit-cost ratio gives the cost-effectiveness of moving to a more costly strategy, by comparing the additional benefits received to the additional costs of the strategy. For example, it is possible for a more costly strategy to add very little benefits for the additional cost of the project. In that case it would be more cost-effective to choose the lower cost alternative. Of course the opposite may be the case. A more costly strategy could generate far more benefits than additional costs, making the higher cost alternative cost effective.

Table 6 gives the incremental benefits and costs of the rehabilitation strategies, arranged in order of lowest cost to highest cost. The increment is from the previous strategy to the next higher strategy. The net benefits in the table represent the sum of motorist benefits and reduction in maintenance costs. The costs are the construction costs. Again, a benefit-cost ratio greater than one indicates the strategy is cost-effective as compared to the next lower cost strategy.

Table 6. Incremental Benefits and Costs of the Rehabilitation Strategies

Incremental Benefits and Costs	Current ADT							
	250	500	750	1000	1500	2000	2500	3000
Minimal Rehab								
Net Benefits	0.06	0.08	0.10	0.11	0.15	0.19	0.23	0.27
Cost	0.08	0.08	0.08	0.08	0.08	0.08	0.08	0.08
Benefit-Cost Ratio	0.76	0.98	1.20	1.43	1.89	2.36	2.84	3.32
Partial Upgrade								
Incremental Benefits	0.03	0.06	0.10	0.13	0.19	0.26	0.32	0.39
Incremental Cost	0.15	0.15	0.15	0.15	0.15	0.15	0.15	0.15
Benefit-Cost Ratio	0.22	0.43	0.65	0.85	1.28	1.70	2.15	2.60
Full Upgrade								
Incremental Benefits	0.02	0.04	0.05	0.07	0.11	0.14	0.18	0.23
Incremental Cost	0.14	0.14	0.14	0.14	0.14	0.14	0.14	0.14
Benefit-Cost Ratio	0.12	0.25	0.36	0.50	0.75	1.03	1.31	1.61

It is clear from the preceding estimates that it is not cost-effective to require full RRR design standards for all low-volume rural roads. As the ADT goes up, higher standards become more cost-effective. Given the results in Table 6, the minimal rehabilitation strategy is most cost-effective between 500 and 1500 ADT, the partial upgrade strategy between 1500 and 2000 ADT, and the full upgrade strategy for ADT 2000 and above. While cost-effectiveness should not be the only criteria for setting design standards, the results would seem to justify some modification of the RRR design standards to take into account the potential benefits as compared to the additional costs.

Several selected outputs from HEEM-III, used in this section of the report, are contained in Appendices A through C.

Figure 2 gives the cost-effectiveness of going from a partial upgrade to standards strategy to a full upgrade to standards strategy, the last increment in Table 6. Each one of the curves on the graph represent a different amount of additional construction costs per mile the full upgrade will cost as compared to the partial upgrade. On the vertical axis is benefit-cost ratio, and on the horizontal axis is the ADT. This figure can be used to quickly determine at what point a proposed project would become cost effective to upgrade to full standards, when compared to a partial upgrade to standards strategy.

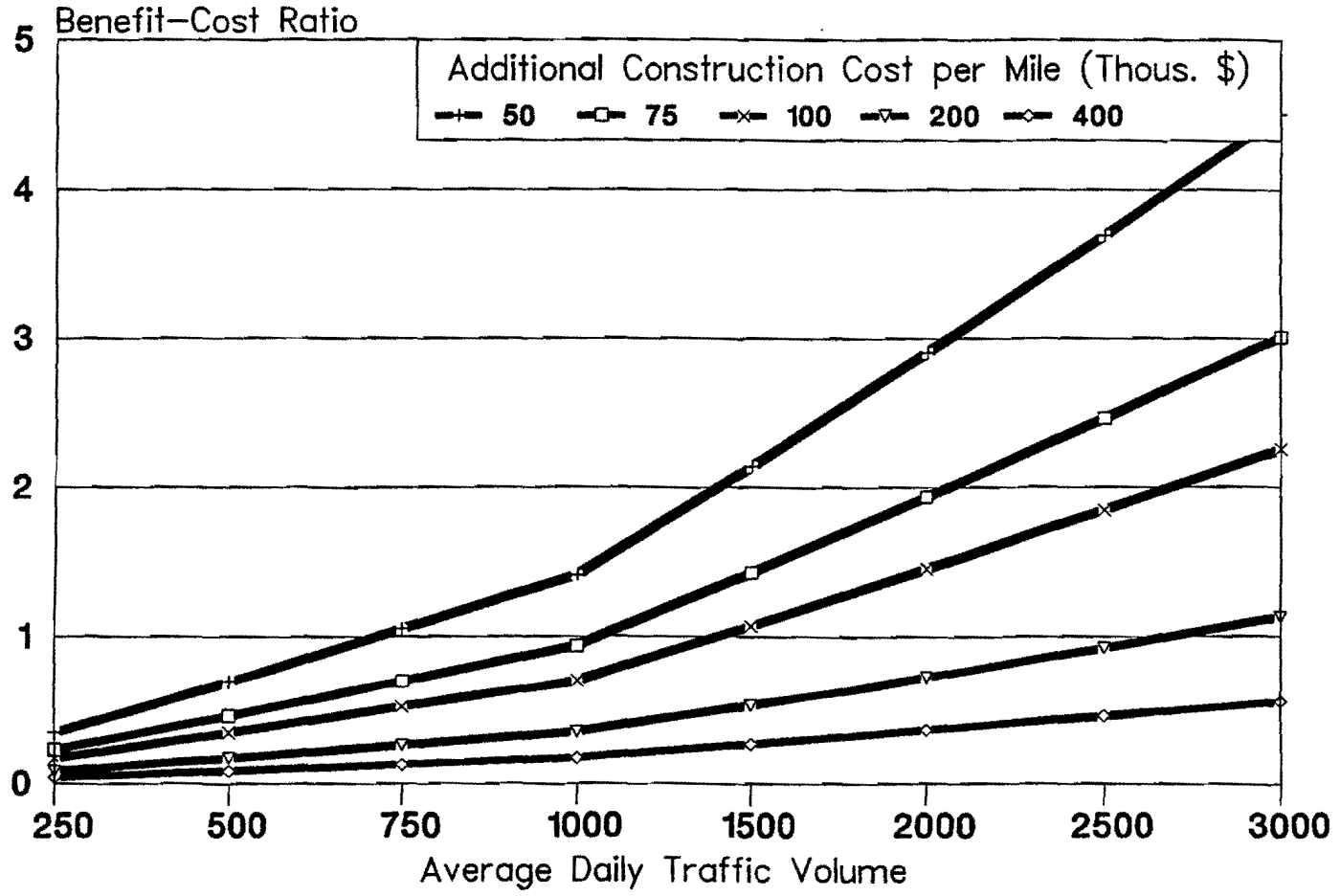

Figure 2. Cost-Effectiveness of Rehabilitation with Full Upgrade to Standards when compared to Partial Upgrade to Standards Strategy

USE OF HEEM-III TO MAKE COST-EFFECTIVENESS ESTIMATES

The HEEM-III computer program [14] provides a simple, consistent, and comprehensive framework to make cost-effectiveness estimates of a wide variety of rehabilitation and other highway improvement projects. It is the only PC computer program currently available for making estimates of the benefits and costs of pavement rehabilitation projects within a framework of a motorist user benefit-cost model. Only a very limited amount of data are required to run the model with several default values which can be changed for specific applications. The output gives information on the traffic volumes, speeds, and user benefits over the analysis period, as well as summary data on the benefits, costs, and benefit-cost ratio.

SETTING UP THE INPUT DATA SET

To run a problem with HEEM-III, first determine both the existing and proposed routes. The existing route is the route without any improvement. The proposed route is the improved existing route. In the analysis, the costs of the proposed route are compared to the existing route to determine the benefits of the improvement. Next determine whether the routes need to be divided up into more than one segment. Multiple segments could be used to divide up routes with significant changes in the design or traffic volume.

Only a very limited amount of data are required to analyze a problem. Most items have default values supplied by the program. A list of the data items required to analyze a problem are given below:

1. Current Year,
2. Total Construction Cost,
3. Category of Project (choose "added-capacity"),
4. Area Type (rural or urban),
5. Current and Forecasted Traffic Volumes,
6. Total Number of Lanes for Existing and Proposed Route Segments,

7. Type of Intersection/Interchange for Existing and Proposed Route, Segments (choose "none" unless an intersection is to be included in the analysis),
8. Length of Existing and Proposed Route Segments,
9. Type of Facility for Existing and Proposed Route Segments (choose "undivided").

Several optional data items are of particular interest in evaluating rehabilitation and upgrade to standards projects. They are listed below under the screen menu where they are located.

EXISTING ROUTE SEGMENT, OTHER TRAFFIC DATA

4. Free Flow Speed on Major Route (mph)
5. Accident Adjustment Factor
6. Capacity per Lane on Major Route (vphpl)

PAVEMENT CONDITION AND MAINT/REHAB COST DATA

Year Pavement Condition (PSI)

Year Maint/Rehab Cost

Free Flow Speed on Major Route (mph)

This item gives the average free flow speed along the route segment. The default is 55 for a rural highway. This should be adjusted for substandard curves which require motorists to slow down. It should be emphasized that this item is the average free flow speed over the entire segment, not the minimum speed or the design speed.

Accident Adjustment Factor

This item gives a factor to adjust the accident rate for unusually high or low accident experience or severity along the route segment. The default is one. The adjustment factor is multiplicative. An adjustment factor greater than one will increase the calculated accident costs for the segment by that factor, while a number less than one will lower the calculated accident costs. For example, an adjustment factor of 2.00 would double the accident costs. The range of the factor is limited to between 0.01 and 9.99.

Unfortunately there is no definitive guide to determine the appropriate adjustment factor for a given set of geometric features or operational characteristics. If accident experience along the route is available, that information could be used to make a rough estimate for the factor, otherwise subjective judgement is required. This is an area that will require additional work in the future.

Capacity per Lane on Major Route (vphpl)

This item gives the capacity per hour per lane on the route segment. This item is used in calculating the average travel speed for a given traffic volume. The default is 1100 for a rural two-lane highway. The default is adjusted internally by the program for the percent trucks. Table 7 gives capacity adjustments for narrow lanes and shoulders, taken from the Highway Capacity Manual (HCM) [15]. It is multiplicative, so multiply the factor from Table 7 by the capacity given by the program, to obtain the adjusted segment capacity. For other adjustments, such as directional splits and percent sight distance, refer to the HCM, chapter 8.

Table 7. Capacity Adjustments for Lane Width and Shoulder Width

Usable Shoulder Width (FT)	Lane Width			
	12 Foot	11 Foot	10 Foot	9 Foot
6	1.00	0.94	0.87	0.76
4	0.97	0.92	0.85	0.74
2	0.93	0.88	0.81	0.70
0	0.88	0.82	0.75	0.66

Pavement Condition (PSI)

The pavement condition is given for each year over the analysis period. The pavement condition is represented by the Present Serviceability Index (PSI), a number which can range from 0.1 to 5.0. The default is 3.1 for rural undivided highways. The program does not internally deteriorate the pavement. Changes in pavement condition over time would have to be provided by the user. The default value can be changed to a different value for all years, or changed for individual years. A potential source of pavement condition data for this item comes from the Pavement Evaluation System (PES) rideability score.

Maint/Rehab Cost

The maintenance/rehabilitation cost is given for each year over the analysis period. The cost is a combined annual cost of both routine maintenance and any additional pavement rehabilitation costs beyond the initial costs (which would be included in the construction cost). The default is a constant value over the analysis period, and is $2,430 per lane mile for rural undivided highways. Any changes in the cost over time would have to be supplied by the user. The default value can be changed to a different value for all years, or changed for individual years.

USING HEEM-III

There are two basic ways to start the analysis. The first is by creating an input data set through the data entry process. The second is to retrieve a previously created data set that had been saved in a file. The data entry process prompts the user for the required data listed above. The optional data may also be entered when access is given to those menus during the data entry, otherwise they can be changed after data entry is complete through the data edit.

When the data entry is complete, or after an input data file is read, the Main Menu becomes available. Several items on the Main Menu are of particular interest. Item 2 allows editing of any data item in the data set. These data items are accessed through

a series of menus arranged in hierarchial fashion. Item 6 is used to run an analysis of the current data set. The analysis may take a second or less, up to several minutes, depending on the number of segments and the type of PC running the program. Of particular importance is a math chip. Due to the large number of calculations, a math chip can significantly reduce the time it takes for the analysis to be completed. Item 7 is used to view the output on the screen, save it to a file, or to send it to a printer. Item 8 allows the user to save the input data file for use in future sessions.

The program may also be used for such things as sensitivity analysis, similar to the results presented in the previous sections for various levels of ADT. It is a relatively simple matter to change one or more data items and then repeat the analysis. Such items as capacity, free flow speed, accident adjustment factor, and pavement condition could easily be examined over a range of values using the program.

Examples of several of the analyses used in the previous section of the report are contained in Appendices A through C. These examples give the echo of the input data, as well as the summary output, so it would be a simple matter to follow the echo input information to set up the input data sets used in the analysis.

ALTERNATIVE POLICIES AND PROCEDURES

It is apparent from the discussions with the districts that substandard rural highways are a source of significant frustration. Lack of adequate ROW prevents them from making the improvements on these highways they would like, because they cannot be brought up to standard. The design exception process is viewed as being too difficult and complex to make any significant improvement in the situation. In the meantime, maintenance money is being consumed which could be better used in other applications.

Several potential short-term alternatives are given below to reduce the problem, and long-term alternatives to solve the problem.

POSSIBLE SHORT-TERM ALTERNATIVES

Short-term alternatives are options which do not require changes in the law or other legislative action. In that sense, they can be implemented within a shorter time frame and control maintained by TxDOT. These alternatives are:

1. *Provide Improved Design Exception Guidelines*

   One of the problems with the current design exception process is, with a few exceptions, districts view the process as complicated and cumbersome. There is some sentiment that there seems to be little connection between the design exception requirements and the criteria used to determine whether a design exception is granted. Much of the problem may be due to lack of experience and exposure of district personnel to the process. It would be of great value to give more detailed guidance on the criteria to be used to approve a design exception for a specific project, the evaluation process itself, and any additional information, not required in the design exception request, that would expedite the evaluation or improve the chances of approval.

2. *Restructure Design Exception Review Process*

The design exception review process is currently handled internally within D-8, Highway Design Division. It is viewed somewhat by the districts as complex and burdensome, with multiple requests for information as the request works its way up the review process. D-8 is considering using a review panel for the process which would include personnel from several divisions and districts. Participation by district personnel would be particularly beneficial, because it would give them exposure to the design exception process, the data and documentation requirements, and the circumstances when design exceptions are appropriate.

3. *Modify Design Standards*

It is apparent from the results in this study that it is not cost-effective to require full RRR design standards for low-volume rural highways. While the design exception process can absorb some of the problem, it would seem prudent to allow low-volume rural roads to be rehabilitated with lower design standards than those required for higher volume highways. It would save money and still allow for needed improvements to be made on these roads. If changes in design standards are not feasible, it would be helpful to include the cost-effectiveness of eliminating design deficiencies as one of the criteria in the design exception process.

POSSIBLE LONG-TERM ALTERNATIVES

Long-term alternatives would require action by the Texas Legislature. These alternatives are listed below:

1. *Allow State Participation for FM ROW Acquisition*

The single biggest problem facing districts with substandard FM highways is the narrow ROW many of these highways were built in. Any additional ROW must be provided by local government. TxDOT is prohibited by state law of providing any matching money to assist in purchasing ROW for FM highways. That is not the case for other highway classifications. One

obvious solution would be to allow State participation in ROW acquisition for FM highways similar to the rules for other highways. The drawback to this is that any money spent on ROW acquisition would have to come from other funds, reducing the amount available for other improvements. However, given the large maintenance expenditure on the FM system, it may be more cost-effective in the long-run to spend some money on ROW acquisition and rehabilitate the highways, reducing the maintenance expenditures.

2. *Legislature Provide Funds for ROW Acquisition*

   One way to overcome the problem of spending money on ROW acquisition needed in other areas, would be for the legislature to appropriate money earmarked for that purpose. While it is not easy to obtain legislative action to appropriate funds, the results of this study clearly indicate it would save the State of Texas and users of FM highways to rehabilitate many of these highways rather than continue using maintenance money. A relatively small expenditure on ROW would have substantial benefits and cost savings in the future.

3. *Use Local Option Highway Improvement Funds*

   Another possibility for raising funds to buy ROW is through a new proposal for a local option gasoline tax, earmarked for highway improvements. While there are several distributional and equity aspects that need to be worked out, this idea does give the potential for rural areas to fund some highway improvements that are not possible with current funding sources.

CONCLUSION

It is clear from the estimates made in this study that it is not cost-effective to require full RRR design standards for all low-volume rural roads. As the ADT goes up, higher standards become more cost-effective. Given the results in the report, a minimal rehabilitation strategy is most cost-effective between 500 and 1500 ADT, a partial upgrade strategy between 1500 and 2000 ADT, and a full upgrade strategy for ADT 2000 and above. While cost-effectiveness should not be the only criteria for setting design standards, the results would seem to justify some modification of the RRR design standards to take into account the potential benefits as compared to the additional costs.

It is also apparent that something should be done about the inability of districts to acquire ROW when it is needed to rehabilitate a highway. Several options are presented in the report, but the one that seems to have the greatest likelihood of success is for TxDOT to be given authority to participate in FM ROW acquisition through a matching money program similar to existing programs for other highway classes. This would give the districts the flexibility to make the tradeoffs between rehabilitation and continued use of maintenance money on these substandard FM highways.

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APPENDIX A - SELECTED OUTPUT FOR COMPARISON OF MAINTENANCE ONLY VS MINIMAL REHABILITATION

OUTPUT FOR ADT=500

11/28/92 10:53

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Min Rehab .

PROBLEM ASSUMPTIONS

1.	Problem Description: Maint only vs Min Rehab	.
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.08

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .

ROUTE DATA

1. Route Description: Maintenance Only .
2. Current Year Through ADT without Improvement (Thous.): 0.50
3. Forecasted Through ADT without Improvement (Thous.): 0.75
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 45
5. Accident Adjustment Factor: 9.99
6. Capacity per Lane on Major Route (vphpl): 743
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .

ROUTE DATA

1.	Route Description: Minimal Rehab	.
4.	Current Year Through ADT with Improvement (Thous.):	0.50
5.	Forecasted Through ADT with Improvement (Thous.):	0.75
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	2.90	520
1993	2.90	520	2007	2.90	520
1994	2.90	520	2008	2.90	520
1995	2.90	520	2009	2.90	520
1996	2.90	520	2010	2.90	520
1997	2.90	520	2011	2.90	520
1998	2.90	520	2012	2.90	520
1999	2.90	520			
2000	2.90	520			
2001	2.90	520			
2002	2.90	520			
2003	2.90	520			
2004	2.90	520			
2005	2.90	520			

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	HOV Facility Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	Combined Total Num. Veh. (000)	Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	45.00	0.50	0.63	0.00	0.00	0.00	0.50	0.63	0.00
1993	44.99	0.51	0.65	0.00	0.00	0.00	0.51	0.65	0.00
1994	44.99	0.52	0.66	0.00	0.00	0.00	0.52	0.66	0.00
1995	44.99	0.53	0.67	0.00	0.00	0.00	0.53	0.67	0.00
1996	44.99	0.54	0.69	0.00	0.00	0.00	0.54	0.69	0.00
1997	44.99	0.55	0.70	0.00	0.00	0.00	0.55	0.70	0.00
1998	44.99	0.56	0.72	0.00	0.00	0.00	0.56	0.72	0.00
1999	44.99	0.58	0.73	0.00	0.00	0.00	0.58	0.73	0.00
2000	44.99	0.59	0.75	0.00	0.00	0.00	0.59	0.75	0.00
2001	44.99	0.60	0.76	0.00	0.00	0.00	0.60	0.76	0.00
2002	44.99	0.61	0.78	0.00	0.00	0.00	0.61	0.78	0.00
2003	44.99	0.62	0.79	0.00	0.00	0.00	0.62	0.79	0.00
2004	44.99	0.64	0.81	0.00	0.00	0.00	0.64	0.81	0.00
2005	44.99	0.65	0.82	0.00	0.00	0.00	0.65	0.82	0.00
2006	44.99	0.66	0.84	0.00	0.00	0.00	0.66	0.84	0.00
2007	44.99	0.68	0.86	0.00	0.00	0.00	0.68	0.86	0.00
2008	44.99	0.69	0.88	0.00	0.00	0.00	0.69	0.88	0.00
2009	44.99	0.71	0.89	0.00	0.00	0.00	0.71	0.89	0.00
2010	44.99	0.72	0.91	0.00	0.00	0.00	0.72	0.91	0.00
2011	44.99	0.73	0.93	0.00	0.00	0.00	0.73	0.93	0.00
2012	44.99	0.75	0.95	0.00	0.00	0.00	0.75	0.95	0.00

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	HOV Facility Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	Combined Total Num. Veh. (000)	Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	44.99	0.51	0.65	0.00	0.00	0.00	0.51	0.65	0.00
1994	44.99	0.52	0.66	0.00	0.00	0.00	0.52	0.66	0.00
1995	44.99	0.53	0.67	0.00	0.00	0.00	0.53	0.67	0.00
1996	44.99	0.54	0.69	0.00	0.00	0.00	0.54	0.69	0.00
1997	44.99	0.55	0.70	0.00	0.00	0.00	0.55	0.70	0.00
1998	44.99	0.56	0.72	0.00	0.00	0.00	0.56	0.72	0.00
1999	44.99	0.58	0.73	0.00	0.00	0.00	0.58	0.73	0.00
2000	44.99	0.59	0.75	0.00	0.00	0.00	0.59	0.75	0.00
2001	44.99	0.60	0.76	0.00	0.00	0.00	0.60	0.76	0.00
2002	44.99	0.61	0.78	0.00	0.00	0.00	0.61	0.78	0.00
2003	44.99	0.62	0.79	0.00	0.00	0.00	0.62	0.79	0.00
2004	44.99	0.64	0.81	0.00	0.00	0.00	0.64	0.81	0.00
2005	44.99	0.65	0.82	0.00	0.00	0.00	0.65	0.82	0.00
2006	44.99	0.66	0.84	0.00	0.00	0.00	0.66	0.84	0.00
2007	44.99	0.68	0.86	0.00	0.00	0.00	0.68	0.86	0.00
2008	44.99	0.69	0.88	0.00	0.00	0.00	0.69	0.88	0.00
2009	44.99	0.71	0.89	0.00	0.00	0.00	0.71	0.89	0.00
2010	44.99	0.72	0.91	0.00	0.00	0.00	0.72	0.91	0.00
2011	44.99	0.73	0.93	0.00	0.00	0.00	0.73	0.93	0.00
2012	44.99	0.75	0.95	0.00	0.00	0.00	0.75	0.95	0.00

Problem Number 1 Maint only vs Min Rehab .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	0.50	0.00	0.00	0.00	0.00	0.50
1993	0.51	0.00	0.00	0.00	0.00	0.51
1994	0.52	0.00	0.00	0.00	0.00	0.52
1995	0.53	0.00	0.00	0.00	0.00	0.53
1996	0.54	0.00	0.00	0.00	0.00	0.54
1997	0.55	0.00	0.00	0.00	0.00	0.55
1998	0.56	0.00	0.00	0.00	0.00	0.56
1999	0.58	0.00	0.00	0.00	0.00	0.58
2000	0.59	0.00	0.00	0.00	0.00	0.59
2001	0.60	0.00	0.00	0.00	0.00	0.60
2002	0.61	0.00	0.00	0.00	0.00	0.61
2003	0.62	0.00	0.00	0.00	0.00	0.62
2004	0.64	0.00	0.00	0.00	0.00	0.64
2005	0.65	0.00	0.00	0.00	0.00	0.65
2006	0.66	0.00	0.00	0.00	0.00	0.66
2007	0.68	0.00	0.00	0.00	0.00	0.68
2008	0.69	0.00	0.00	0.00	0.00	0.69
2009	0.71	0.00	0.00	0.00	0.00	0.71
2010	0.72	0.00	0.00	0.00	0.00	0.72
2011	0.73	0.00	0.00	0.00	0.00	0.73
2012	0.75	0.00	0.00	0.00	0.00	0.75

Problem Number 1 Maint only vs Min Rehab .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	0.00	2.89	0.00	2.89
1994	0.00	2.73	0.00	2.73
1995	0.00	2.58	0.00	2.58
1996	0.00	2.44	0.00	2.44
1997	0.00	2.30	0.00	2.30
1998	0.00	2.18	0.00	2.18
1999	0.00	2.06	0.00	2.06
2000	0.00	1.94	0.00	1.94
2001	0.00	1.84	0.00	1.84
2002	0.00	1.74	0.00	1.74
2003	0.00	1.64	0.00	1.64
2004	0.00	1.55	0.00	1.55
2005	0.00	1.47	0.00	1.47
2006	0.00	1.39	0.00	1.39
2007	0.00	1.31	0.00	1.31
2008	0.00	1.24	0.00	1.24
2009	0.00	1.17	0.00	1.17
2010	0.00	1.11	0.00	1.11
2011	0.00	1.04	0.00	1.04
2012	0.00	0.99	0.00	0.99
Total	0.00	35.59	0.00	35.59

Total Discounted User Benefits (Millions $) :	0.04
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.04
Discounted Construction Cost (Millions $) :	0.08
Net Present Value (Millions $) :	0.00
Benefit-Cost Ratio :	0.98

OUTPUT FOR ADT=1,000

11/28/92 10:59

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Min Rehab .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Min Rehab .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.08

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .

ROUTE DATA

1. Route Description: Maintenance Only .
2. Current Year Through ADT without Improvement (Thous.): 1.00
3. Forecasted Through ADT without Improvement (Thous.): 1.50
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 45
5. Accident Adjustment Factor: 9.99
6. Capacity per Lane on Major Route (vphpl): 743
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .

ROUTE DATA

1.	Route Description: Minimal Rehab	.
4.	Current Year Through ADT with Improvement (Thous.):	1.00
5.	Forecasted Through ADT with Improvement (Thous.):	1.50
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	2.90	520
1993	2.90	520	2007	2.90	520
1994	2.90	520	2008	2.90	520
1995	2.90	520	2009	2.90	520
1996	2.90	520	2010	2.90	520
1997	2.90	520	2011	2.90	520
1998	2.90	520	2012	2.90	520
1999	2.90	520			
2000	2.90	520			
2001	2.90	520			
2002	2.90	520			
2003	2.90	520			
2004	2.90	520			
2005	2.90	520			

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.98	1.00	1.27	0.00	0.00	0.00	1.00	1.27	0.00
1993	44.98	1.02	1.29	0.00	0.00	0.00	1.02	1.29	0.00
1994	44.98	1.04	1.32	0.00	0.00	0.00	1.04	1.32	0.00
1995	44.98	1.06	1.35	0.00	0.00	0.00	1.06	1.35	0.00
1996	44.98	1.08	1.37	0.00	0.00	0.00	1.08	1.37	0.00
1997	44.98	1.11	1.40	0.00	0.00	0.00	1.11	1.40	0.00
1998	44.98	1.13	1.43	0.00	0.00	0.00	1.13	1.43	0.00
1999	44.97	1.15	1.46	0.00	0.00	0.00	1.15	1.46	0.00
2000	44.97	1.18	1.49	0.00	0.00	0.00	1.18	1.49	0.00
2001	44.97	1.20	1.52	0.00	0.00	0.00	1.20	1.52	0.00
2002	44.97	1.22	1.55	0.00	0.00	0.00	1.22	1.55	0.00
2003	44.97	1.25	1.58	0.00	0.00	0.00	1.25	1.58	0.00
2004	44.97	1.28	1.62	0.00	0.00	0.00	1.28	1.62	0.00
2005	44.97	1.30	1.65	0.00	0.00	0.00	1.30	1.65	0.00
2006	44.97	1.33	1.68	0.00	0.00	0.00	1.33	1.68	0.00
2007	44.96	1.36	1.72	0.00	0.00	0.00	1.36	1.72	0.00
2008	44.96	1.38	1.75	0.00	0.00	0.00	1.38	1.75	0.00
2009	44.96	1.41	1.79	0.00	0.00	0.00	1.41	1.79	0.00
2010	44.96	1.44	1.82	0.00	0.00	0.00	1.44	1.82	0.00
2011	44.96	1.47	1.86	0.00	0.00	0.00	1.47	1.86	0.00
2012	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	44.98	1.02	1.29	0.00	0.00	0.00	1.02	1.29	0.00
1994	44.98	1.04	1.32	0.00	0.00	0.00	1.04	1.32	0.00
1995	44.98	1.06	1.35	0.00	0.00	0.00	1.06	1.35	0.00
1996	44.98	1.08	1.37	0.00	0.00	0.00	1.08	1.37	0.00
1997	44.98	1.11	1.40	0.00	0.00	0.00	1.11	1.40	0.00
1998	44.98	1.13	1.43	0.00	0.00	0.00	1.13	1.43	0.00
1999	44.97	1.15	1.46	0.00	0.00	0.00	1.15	1.46	0.00
2000	44.97	1.18	1.49	0.00	0.00	0.00	1.18	1.49	0.00
2001	44.97	1.20	1.52	0.00	0.00	0.00	1.20	1.52	0.00
2002	44.97	1.22	1.55	0.00	0.00	0.00	1.22	1.55	0.00
2003	44.97	1.25	1.58	0.00	0.00	0.00	1.25	1.58	0.00
2004	44.97	1.28	1.62	0.00	0.00	0.00	1.28	1.62	0.00
2005	44.97	1.30	1.65	0.00	0.00	0.00	1.30	1.65	0.00
2006	44.97	1.33	1.68	0.00	0.00	0.00	1.33	1.68	0.00
2007	44.96	1.36	1.72	0.00	0.00	0.00	1.36	1.72	0.00
2008	44.96	1.38	1.75	0.00	0.00	0.00	1.38	1.75	0.00
2009	44.96	1.41	1.79	0.00	0.00	0.00	1.41	1.79	0.00
2010	44.96	1.44	1.82	0.00	0.00	0.00	1.44	1.82	0.00
2011	44.96	1.47	1.86	0.00	0.00	0.00	1.47	1.86	0.00
2012	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00

Problem Number 1 Maint only vs Min Rehab .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	1.00	0.00	0.00	0.00	0.00	1.00
1993	1.02	0.00	0.00	0.00	0.00	1.02
1994	1.04	0.00	0.00	0.00	0.00	1.04
1995	1.06	0.00	0.00	0.00	0.00	1.06
1996	1.08	0.00	0.00	0.00	0.00	1.08
1997	1.11	0.00	0.00	0.00	0.00	1.11
1998	1.13	0.00	0.00	0.00	0.00	1.13
1999	1.15	0.00	0.00	0.00	0.00	1.15
2000	1.18	0.00	0.00	0.00	0.00	1.18
2001	1.20	0.00	0.00	0.00	0.00	1.20
2002	1.22	0.00	0.00	0.00	0.00	1.22
2003	1.25	0.00	0.00	0.00	0.00	1.25
2004	1.28	0.00	0.00	0.00	0.00	1.28
2005	1.30	0.00	0.00	0.00	0.00	1.30
2006	1.33	0.00	0.00	0.00	0.00	1.33
2007	1.36	0.00	0.00	0.00	0.00	1.36
2008	1.38	0.00	0.00	0.00	0.00	1.38
2009	1.41	0.00	0.00	0.00	0.00	1.41
2010	1.44	0.00	0.00	0.00	0.00	1.44
2011	1.47	0.00	0.00	0.00	0.00	1.47
2012	1.50	0.00	0.00	0.00	0.00	1.50

Problem Number 1 Maint only vs Min Rehab .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	0.00	5.82	0.00	5.82
1994	0.00	5.50	0.00	5.50
1995	0.00	5.20	0.00	5.20
1996	0.00	4.92	0.00	4.92
1997	0.00	4.65	0.00	4.65
1998	0.00	4.39	0.00	4.39
1999	0.00	4.15	0.00	4.15
2000	0.00	3.92	0.00	3.92
2001	0.00	3.71	0.00	3.71
2002	0.00	3.51	0.00	3.51
2003	0.00	3.31	0.00	3.31
2004	0.00	3.13	0.00	3.13
2005	0.00	2.96	0.00	2.96
2006	0.00	2.80	0.00	2.80
2007	0.00	2.65	0.00	2.65
2008	0.00	2.50	0.00	2.50
2009	0.00	2.36	0.00	2.36
2010	0.00	2.23	0.00	2.23
2011	0.00	2.11	0.00	2.11
2012	0.00	2.00	0.00	2.00
Total	0.00	71.82	0.00	71.82

Total Discounted User Benefits (Millions $) : 0.07
Total Discounted Reduction in Maint/Rehab Costs (Millions $) : 0.04
Discounted Construction Cost (Millions $) : 0.08
Net Present Value (Millions $) : 0.03
Benefit-Cost Ratio : 1.43

OUTPUT FOR ADT=1,500

11/28/92 11:03

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Min Rehab .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Min Rehab .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.08

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .

ROUTE DATA

1. Route Description: Maintenance Only .
2. Current Year Through ADT without Improvement (Thous.): 1.50
3. Forecasted Through ADT without Improvement (Thous.): 2.25
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 45
5. Accident Adjustment Factor: 9.99
6. Capacity per Lane on Major Route (vphpl): 743
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .

ROUTE DATA

1.	Route Description: Minimal Rehab	.
4.	Current Year Through ADT with Improvement (Thous.):	1.50
5.	Forecasted Through ADT with Improvement (Thous.):	2.25
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	2.90	520
1993	2.90	520	2007	2.90	520
1994	2.90	520	2008	2.90	520
1995	2.90	520	2009	2.90	520
1996	2.90	520	2010	2.90	520
1997	2.90	520	2011	2.90	520
1998	2.90	520	2012	2.90	520
1999	2.90	520			
2000	2.90	520			
2001	2.90	520			
2002	2.90	520			
2003	2.90	520			
2004	2.90	520			
2005	2.90	520			

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00
1993	44.95	1.53	1.94	0.00	0.00	0.00	1.53	1.94	0.00
1994	44.95	1.56	1.98	0.00	0.00	0.00	1.56	1.98	0.00
1995	44.95	1.59	2.02	0.00	0.00	0.00	1.59	2.02	0.00
1996	44.95	1.63	2.06	0.00	0.00	0.00	1.63	2.06	0.00
1997	44.95	1.66	2.10	0.00	0.00	0.00	1.66	2.10	0.00
1998	44.94	1.69	2.15	0.00	0.00	0.00	1.69	2.15	0.00
1999	44.94	1.73	2.19	0.00	0.00	0.00	1.73	2.19	0.00
2000	44.94	1.76	2.24	0.00	0.00	0.00	1.76	2.24	0.00
2001	44.94	1.80	2.28	0.00	0.00	0.00	1.80	2.28	0.00
2002	44.93	1.84	2.33	0.00	0.00	0.00	1.84	2.33	0.00
2003	44.93	1.87	2.38	0.00	0.00	0.00	1.87	2.38	0.00
2004	44.93	1.91	2.42	0.00	0.00	0.00	1.91	2.42	0.00
2005	44.93	1.95	2.47	0.00	0.00	0.00	1.95	2.47	0.00
2006	44.92	1.99	2.52	0.00	0.00	0.00	1.99	2.52	0.00
2007	44.92	2.03	2.58	0.00	0.00	0.00	2.03	2.58	0.00
2008	44.92	2.07	2.63	0.00	0.00	0.00	2.07	2.63	0.00
2009	44.91	2.12	2.68	0.00	0.00	0.00	2.12	2.68	0.00
2010	44.91	2.16	2.74	0.00	0.00	0.00	2.16	2.74	0.00
2011	44.91	2.20	2.79	0.00	0.00	0.00	2.20	2.79	0.00
2012	44.90	2.25	2.85	0.00	0.00	0.00	2.25	2.85	0.00

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	44.95	1.53	1.94	0.00	0.00	0.00	1.53	1.94	0.00
1994	44.95	1.56	1.98	0.00	0.00	0.00	1.56	1.98	0.00
1995	44.95	1.59	2.02	0.00	0.00	0.00	1.59	2.02	0.00
1996	44.95	1.63	2.06	0.00	0.00	0.00	1.63	2.06	0.00
1997	44.95	1.66	2.10	0.00	0.00	0.00	1.66	2.10	0.00
1998	44.94	1.69	2.15	0.00	0.00	0.00	1.69	2.15	0.00
1999	44.94	1.73	2.19	0.00	0.00	0.00	1.73	2.19	0.00
2000	44.94	1.76	2.24	0.00	0.00	0.00	1.76	2.24	0.00
2001	44.94	1.80	2.28	0.00	0.00	0.00	1.80	2.28	0.00
2002	44.93	1.84	2.33	0.00	0.00	0.00	1.84	2.33	0.00
2003	44.93	1.87	2.38	0.00	0.00	0.00	1.87	2.38	0.00
2004	44.93	1.91	2.42	0.00	0.00	0.00	1.91	2.42	0.00
2005	44.93	1.95	2.47	0.00	0.00	0.00	1.95	2.47	0.00
2006	44.92	1.99	2.52	0.00	0.00	0.00	1.99	2.52	0.00
2007	44.92	2.03	2.58	0.00	0.00	0.00	2.03	2.58	0.00
2008	44.92	2.07	2.63	0.00	0.00	0.00	2.07	2.63	0.00
2009	44.91	2.12	2.68	0.00	0.00	0.00	2.12	2.68	0.00
2010	44.91	2.16	2.74	0.00	0.00	0.00	2.16	2.74	0.00
2011	44.91	2.20	2.79	0.00	0.00	0.00	2.20	2.79	0.00
2012	44.90	2.25	2.85	0.00	0.00	0.00	2.25	2.85	0.00

Problem Number 1 Maint only vs Min Rehab .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	1.50	0.00	0.00	0.00	0.00	1.50
1993	1.53	0.00	0.00	0.00	0.00	1.53
1994	1.56	0.00	0.00	0.00	0.00	1.56
1995	1.59	0.00	0.00	0.00	0.00	1.59
1996	1.63	0.00	0.00	0.00	0.00	1.63
1997	1.66	0.00	0.00	0.00	0.00	1.66
1998	1.69	0.00	0.00	0.00	0.00	1.69
1999	1.73	0.00	0.00	0.00	0.00	1.73
2000	1.76	0.00	0.00	0.00	0.00	1.76
2001	1.80	0.00	0.00	0.00	0.00	1.80
2002	1.84	0.00	0.00	0.00	0.00	1.84
2003	1.87	0.00	0.00	0.00	0.00	1.87
2004	1.91	0.00	0.00	0.00	0.00	1.91
2005	1.95	0.00	0.00	0.00	0.00	1.95
2006	1.99	0.00	0.00	0.00	0.00	1.99
2007	2.03	0.00	0.00	0.00	0.00	2.03
2008	2.07	0.00	0.00	0.00	0.00	2.07
2009	2.12	0.00	0.00	0.00	0.00	2.12
2010	2.16	0.00	0.00	0.00	0.00	2.16
2011	2.20	0.00	0.00	0.00	0.00	2.20
2012	2.25	0.00	0.00	0.00	0.00	2.25

Problem Number 1 Maint only vs Min Rehab .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	0.00	8.80	0.00	8.80
1994	0.00	8.32	0.00	8.32
1995	0.00	7.86	0.00	7.86
1996	0.00	7.43	0.00	7.43
1997	0.00	7.03	0.00	7.03
1998	0.00	6.64	0.00	6.64
1999	0.00	6.28	0.00	6.28
2000	0.00	5.94	0.00	5.94
2001	0.00	5.61	0.00	5.61
2002	0.00	5.31	0.00	5.31
2003	0.00	5.02	0.00	5.02
2004	0.00	4.74	0.00	4.74
2005	0.00	4.48	0.00	4.48
2006	0.00	4.24	0.00	4.24
2007	0.00	4.01	0.00	4.01
2008	0.00	3.79	0.00	3.79
2009	0.00	3.58	0.00	3.58
2010	0.00	3.39	0.00	3.39
2011	0.00	3.20	0.00	3.20
2012	0.00	3.03	0.00	3.03
Total	0.00	108.68	0.00	108.68

Total Discounted User Benefits (Millions $) : 0.11
Total Discounted Reduction in Maint/Rehab Costs (Millions $) : 0.04
Discounted Construction Cost (Millions $) : 0.08
Net Present Value (Millions $) : 0.07
Benefit-Cost Ratio : 1.89

OUTPUT FOR ADT=2,000

11/28/92 11:05

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Min Rehab .

PROBLEM ASSUMPTIONS

1.	Problem Description: Maint only vs Min Rehab	.
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.08

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .

ROUTE DATA

1. Route Description: Maintenance Only .
2. Current Year Through ADT without Improvement (Thous.): 2.00
3. Forecasted Through ADT without Improvement (Thous.): 3.00
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 45
5. Accident Adjustment Factor: 9.99
6. Capacity per Lane on Major Route (vphpl): 743
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .

ROUTE DATA

1.	Route Description: Minimal Rehab	.
4.	Current Year Through ADT with Improvement (Thous.):	2.00
5.	Forecasted Through ADT with Improvement (Thous.):	3.00
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	2.90	520
1993	2.90	520	2007	2.90	520
1994	2.90	520	2008	2.90	520
1995	2.90	520	2009	2.90	520
1996	2.90	520	2010	2.90	520
1997	2.90	520	2011	2.90	520
1998	2.90	520	2012	2.90	520
1999	2.90	520			
2000	2.90	520			
2001	2.90	520			
2002	2.90	520			
2003	2.90	520			
2004	2.90	520			
2005	2.90	520			

Problem Number 1 Maint only vs Min Rehab .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.92	2.00	2.53	0.00	0.00	0.00	2.00	2.53	0.00
1993	44.92	2.04	2.59	0.00	0.00	0.00	2.04	2.59	0.00
1994	44.92	2.08	2.64	0.00	0.00	0.00	2.08	2.64	0.00
1995	44.91	2.13	2.69	0.00	0.00	0.00	2.13	2.69	0.00
1996	44.91	2.17	2.75	0.00	0.00	0.00	2.17	2.75	0.00
1997	44.90	2.21	2.80	0.00	0.00	0.00	2.21	2.80	0.00
1998	44.90	2.26	2.86	0.00	0.00	0.00	2.26	2.86	0.00
1999	44.90	2.30	2.92	0.00	0.00	0.00	2.30	2.92	0.00
2000	44.89	2.35	2.98	0.00	0.00	0.00	2.35	2.98	0.00
2001	44.89	2.40	3.04	0.00	0.00	0.00	2.40	3.04	0.00
2002	44.88	2.45	3.10	0.00	0.00	0.00	2.45	3.10	0.00
2003	44.88	2.50	3.17	0.00	0.00	0.00	2.50	3.17	0.00
2004	44.87	2.55	3.23	0.00	0.00	0.00	2.55	3.23	0.00
2005	44.87	2.60	3.30	0.00	0.00	0.00	2.60	3.30	0.00
2006	44.86	2.66	3.37	0.00	0.00	0.00	2.66	3.37	0.00
2007	44.86	2.71	3.43	0.00	0.00	0.00	2.71	3.43	0.00
2008	44.85	2.77	3.50	0.00	0.00	0.00	2.77	3.50	0.00
2009	44.84	2.82	3.58	0.00	0.00	0.00	2.82	3.58	0.00
2010	44.84	2.88	3.65	0.00	0.00	0.00	2.88	3.65	0.00
2011	44.83	2.94	3.72	0.00	0.00	0.00	2.94	3.72	0.00
2012	44.82	3.00	3.80	0.00	0.00	0.00	3.00	3.80	0.00

Problem Number 1 Maint only vs Min Rehab .
PROPOSED Route Minimal Rehab .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	44.92	2.04	2.59	0.00	0.00	0.00	2.04	2.59	0.00
1994	44.92	2.08	2.64	0.00	0.00	0.00	2.08	2.64	0.00
1995	44.91	2.13	2.69	0.00	0.00	0.00	2.13	2.69	0.00
1996	44.91	2.17	2.75	0.00	0.00	0.00	2.17	2.75	0.00
1997	44.90	2.21	2.80	0.00	0.00	0.00	2.21	2.80	0.00
1998	44.90	2.26	2.86	0.00	0.00	0.00	2.26	2.86	0.00
1999	44.90	2.30	2.92	0.00	0.00	0.00	2.30	2.92	0.00
2000	44.89	2.35	2.98	0.00	0.00	0.00	2.35	2.98	0.00
2001	44.89	2.40	3.04	0.00	0.00	0.00	2.40	3.04	0.00
2002	44.88	2.45	3.10	0.00	0.00	0.00	2.45	3.10	0.00
2003	44.88	2.50	3.17	0.00	0.00	0.00	2.50	3.17	0.00
2004	44.87	2.55	3.23	0.00	0.00	0.00	2.55	3.23	0.00
2005	44.87	2.60	3.30	0.00	0.00	0.00	2.60	3.30	0.00
2006	44.86	2.66	3.37	0.00	0.00	0.00	2.66	3.37	0.00
2007	44.86	2.71	3.43	0.00	0.00	0.00	2.71	3.43	0.00
2008	44.85	2.77	3.50	0.00	0.00	0.00	2.77	3.50	0.00
2009	44.84	2.82	3.58	0.00	0.00	0.00	2.82	3.58	0.00
2010	44.84	2.88	3.65	0.00	0.00	0.00	2.88	3.65	0.00
2011	44.83	2.94	3.72	0.00	0.00	0.00	2.94	3.72	0.00
2012	44.82	3.00	3.80	0.00	0.00	0.00	3.00	3.80	0.00

Problem Number 1 Maint only vs Min Rehab .

Daily Through Traffic (Thous.)

	WITHOUT Improvement			WITH Improvment		
Year	Existing	Alternate	Proposed	Existing	Alternate	Proposed
1992	2.00	0.00	0.00	0.00	0.00	2.00
1993	2.04	0.00	0.00	0.00	0.00	2.04
1994	2.08	0.00	0.00	0.00	0.00	2.08
1995	2.13	0.00	0.00	0.00	0.00	2.13
1996	2.17	0.00	0.00	0.00	0.00	2.17
1997	2.21	0.00	0.00	0.00	0.00	2.21
1998	2.26	0.00	0.00	0.00	0.00	2.26
1999	2.30	0.00	0.00	0.00	0.00	2.30
2000	2.35	0.00	0.00	0.00	0.00	2.35
2001	2.40	0.00	0.00	0.00	0.00	2.40
2002	2.45	0.00	0.00	0.00	0.00	2.45
2003	2.50	0.00	0.00	0.00	0.00	2.50
2004	2.55	0.00	0.00	0.00	0.00	2.55
2005	2.60	0.00	0.00	0.00	0.00	2.60
2006	2.66	0.00	0.00	0.00	0.00	2.66
2007	2.71	0.00	0.00	0.00	0.00	2.71
2008	2.77	0.00	0.00	0.00	0.00	2.77
2009	2.82	0.00	0.00	0.00	0.00	2.82
2010	2.88	0.00	0.00	0.00	0.00	2.88
2011	2.94	0.00	0.00	0.00	0.00	2.94
2012	3.00	0.00	0.00	0.00	0.00	3.00

Problem Number 1 Maint only vs Min Rehab .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	0.00	11.82	0.00	11.82
1994	0.00	11.17	0.00	11.17
1995	0.00	10.56	0.00	10.56
1996	0.00	9.99	0.00	9.99
1997	0.00	9.44	0.00	9.44
1998	0.00	8.93	0.00	8.93
1999	0.00	8.44	0.00	8.44
2000	0.00	7.98	0.00	7.98
2001	0.00	7.55	0.00	7.55
2002	0.00	7.14	0.00	7.14
2003	0.00	6.75	0.00	6.75
2004	0.00	6.38	0.00	6.38
2005	0.00	6.03	0.00	6.03
2006	0.00	5.71	0.00	5.71
2007	0.00	5.40	0.00	5.40
2008	0.00	5.10	0.00	5.10
2009	0.00	4.82	0.00	4.82
2010	0.00	4.56	0.00	4.56
2011	0.00	4.31	0.00	4.31
2012	0.00	4.08	0.00	4.08
Total	0.00	146.17	0.00	146.17

Total Discounted User Benefits (Millions $) :	0.15
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.04
Discounted Construction Cost (Millions $) :	0.08
Net Present Value (Millions $) :	0.11
Benefit-Cost Ratio :	2.36

APPENDIX B - SELECTED OUTPUT FOR COMPARISON OF MAINTENANCE ONLY VS REHABILITATION WITH PARTIAL UPGRADE

OUTPUT FOR ADT=500

11/28/92 11:15

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Part Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Part Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.23

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1.	Route Description: Maintenance Only	.
2.	Current Year Through ADT without Improvement (Thous.):	0.50
3.	Forecasted Through ADT without Improvement (Thous.):	0.75
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .

ROUTE DATA

1. Route Description: Rehab with Partial Upgrade .
4. Current Year Through ADT with Improvement (Thous.): 0.50
5. Forecasted Through ADT with Improvement (Thous.): 0.75
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 50
5. Accident Adjustment Factor: 5.00
6. Capacity per Lane on Major Route (vphpl): 842
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	45.00	0.50	0.63	0.00	0.00	0.00	0.50	0.63	0.00
1993	44.99	0.51	0.65	0.00	0.00	0.00	0.51	0.65	0.00
1994	44.99	0.52	0.66	0.00	0.00	0.00	0.52	0.66	0.00
1995	44.99	0.53	0.67	0.00	0.00	0.00	0.53	0.67	0.00
1996	44.99	0.54	0.69	0.00	0.00	0.00	0.54	0.69	0.00
1997	44.99	0.55	0.70	0.00	0.00	0.00	0.55	0.70	0.00
1998	44.99	0.56	0.72	0.00	0.00	0.00	0.56	0.72	0.00
1999	44.99	0.58	0.73	0.00	0.00	0.00	0.58	0.73	0.00
2000	44.99	0.59	0.75	0.00	0.00	0.00	0.59	0.75	0.00
2001	44.99	0.60	0.76	0.00	0.00	0.00	0.60	0.76	0.00
2002	44.99	0.61	0.78	0.00	0.00	0.00	0.61	0.78	0.00
2003	44.99	0.62	0.79	0.00	0.00	0.00	0.62	0.79	0.00
2004	44.99	0.64	0.81	0.00	0.00	0.00	0.64	0.81	0.00
2005	44.99	0.65	0.82	0.00	0.00	0.00	0.65	0.82	0.00
2006	44.99	0.66	0.84	0.00	0.00	0.00	0.66	0.84	0.00
2007	44.99	0.68	0.86	0.00	0.00	0.00	0.68	0.86	0.00
2008	44.99	0.69	0.88	0.00	0.00	0.00	0.69	0.88	0.00
2009	44.99	0.71	0.89	0.00	0.00	0.00	0.71	0.89	0.00
2010	44.99	0.72	0.91	0.00	0.00	0.00	0.72	0.91	0.00
2011	44.99	0.73	0.93	0.00	0.00	0.00	0.73	0.93	0.00
2012	44.99	0.75	0.95	0.00	0.00	0.00	0.75	0.95	0.00

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	50.00	0.51	0.65	0.00	0.00	0.00	0.51	0.65	0.00
1994	50.00	0.52	0.66	0.00	0.00	0.00	0.52	0.66	0.00
1995	50.00	0.53	0.67	0.00	0.00	0.00	0.53	0.67	0.00
1996	50.00	0.54	0.69	0.00	0.00	0.00	0.54	0.69	0.00
1997	49.99	0.55	0.70	0.00	0.00	0.00	0.55	0.70	0.00
1998	49.99	0.56	0.72	0.00	0.00	0.00	0.56	0.72	0.00
1999	49.99	0.58	0.73	0.00	0.00	0.00	0.58	0.73	0.00
2000	49.99	0.59	0.75	0.00	0.00	0.00	0.59	0.75	0.00
2001	49.99	0.60	0.76	0.00	0.00	0.00	0.60	0.76	0.00
2002	49.99	0.61	0.78	0.00	0.00	0.00	0.61	0.78	0.00
2003	49.99	0.62	0.79	0.00	0.00	0.00	0.62	0.79	0.00
2004	49.99	0.64	0.81	0.00	0.00	0.00	0.64	0.81	0.00
2005	49.99	0.65	0.82	0.00	0.00	0.00	0.65	0.82	0.00
2006	49.99	0.66	0.84	0.00	0.00	0.00	0.66	0.84	0.00
2007	49.99	0.68	0.86	0.00	0.00	0.00	0.68	0.86	0.00
2008	49.99	0.69	0.88	0.00	0.00	0.00	0.69	0.88	0.00
2009	49.99	0.71	0.89	0.00	0.00	0.00	0.71	0.89	0.00
2010	49.99	0.72	0.91	0.00	0.00	0.00	0.72	0.91	0.00
2011	49.99	0.73	0.93	0.00	0.00	0.00	0.73	0.93	0.00
2012	49.99	0.75	0.95	0.00	0.00	0.00	0.75	0.95	0.00

Problem Number 1 Maint only vs Part Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	0.50	0.00	0.00	0.00	0.00	0.50
1993	0.51	0.00	0.00	0.00	0.00	0.51
1994	0.52	0.00	0.00	0.00	0.00	0.52
1995	0.53	0.00	0.00	0.00	0.00	0.53
1996	0.54	0.00	0.00	0.00	0.00	0.54
1997	0.55	0.00	0.00	0.00	0.00	0.55
1998	0.56	0.00	0.00	0.00	0.00	0.56
1999	0.58	0.00	0.00	0.00	0.00	0.58
2000	0.59	0.00	0.00	0.00	0.00	0.59
2001	0.60	0.00	0.00	0.00	0.00	0.60
2002	0.61	0.00	0.00	0.00	0.00	0.61
2003	0.62	0.00	0.00	0.00	0.00	0.62
2004	0.64	0.00	0.00	0.00	0.00	0.64
2005	0.65	0.00	0.00	0.00	0.00	0.65
2006	0.66	0.00	0.00	0.00	0.00	0.66
2007	0.68	0.00	0.00	0.00	0.00	0.68
2008	0.69	0.00	0.00	0.00	0.00	0.69
2009	0.71	0.00	0.00	0.00	0.00	0.71
2010	0.72	0.00	0.00	0.00	0.00	0.72
2011	0.73	0.00	0.00	0.00	0.00	0.73
2012	0.75	0.00	0.00	0.00	0.00	0.75

Problem Number 1 Maint only vs Part Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	5.18	2.67	0.08	7.92
1994	4.89	2.52	0.07	7.49
1995	4.62	2.38	0.07	7.08
1996	4.37	2.25	0.07	6.69
1997	4.13	2.13	0.06	6.32
1998	3.90	2.01	0.06	5.97
1999	3.68	1.90	0.06	5.64
2000	3.48	1.80	0.05	5.33
2001	3.29	1.70	0.05	5.04
2002	3.11	1.61	0.05	4.76
2003	2.94	1.52	0.04	4.50
2004	2.78	1.44	0.04	4.25
2005	2.62	1.36	0.04	4.02
2006	2.48	1.28	0.04	3.80
2007	2.34	1.21	0.04	3.59
2008	2.21	1.15	0.03	3.39
2009	2.09	1.08	0.03	3.21
2010	1.98	1.02	0.03	3.03
2011	1.87	0.97	0.03	2.86
2012	1.76	0.92	0.03	2.71
Total	63.71	32.93	0.96	97.61

Total Discounted User Benefits (Millions $) :	0.10
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.23
Net Present Value (Millions $) :	-0.09
Benefit-Cost Ratio :	0.62

OUTPUT FOR ADT=1,000

11/28/92 11:20

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Part Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Part Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.23

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1. Route Description: Maintenance Only .
2. Current Year Through ADT without Improvement (Thous.): 1.00
3. Forecasted Through ADT without Improvement (Thous.): 1.50
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA .

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 45
5. Accident Adjustment Factor: 9.99
6. Capacity per Lane on Major Route (vphpl): 743
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .

ROUTE DATA

1.	Route Description: Rehab with Partial Upgrade	.
4.	Current Year Through ADT with Improvement (Thous.):	1.00
5.	Forecasted Through ADT with Improvement (Thous.):	1.50
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	50
5.	Accident Adjustment Factor:	5.00
6.	Capacity per Lane on Major Route (vphpl):	842
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.98	1.00	1.27	0.00	0.00	0.00	1.00	1.27	0.00
1993	44.98	1.02	1.29	0.00	0.00	0.00	1.02	1.29	0.00
1994	44.98	1.04	1.32	0.00	0.00	0.00	1.04	1.32	0.00
1995	44.98	1.06	1.35	0.00	0.00	0.00	1.06	1.35	0.00
1996	44.98	1.08	1.37	0.00	0.00	0.00	1.08	1.37	0.00
1997	44.98	1.11	1.40	0.00	0.00	0.00	1.11	1.40	0.00
1998	44.98	1.13	1.43	0.00	0.00	0.00	1.13	1.43	0.00
1999	44.97	1.15	1.46	0.00	0.00	0.00	1.15	1.46	0.00
2000	44.97	1.18	1.49	0.00	0.00	0.00	1.18	1.49	0.00
2001	44.97	1.20	1.52	0.00	0.00	0.00	1.20	1.52	0.00
2002	44.97	1.22	1.55	0.00	0.00	0.00	1.22	1.55	0.00
2003	44.97	1.25	1.58	0.00	0.00	0.00	1.25	1.58	0.00
2004	44.97	1.28	1.62	0.00	0.00	0.00	1.28	1.62	0.00
2005	44.97	1.30	1.65	0.00	0.00	0.00	1.30	1.65	0.00
2006	44.97	1.33	1.68	0.00	0.00	0.00	1.33	1.68	0.00
2007	44.96	1.36	1.72	0.00	0.00	0.00	1.36	1.72	0.00
2008	44.96	1.38	1.75	0.00	0.00	0.00	1.38	1.75	0.00
2009	44.96	1.41	1.79	0.00	0.00	0.00	1.41	1.79	0.00
2010	44.96	1.44	1.82	0.00	0.00	0.00	1.44	1.82	0.00
2011	44.96	1.47	1.86	0.00	0.00	0.00	1.47	1.86	0.00
2012	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	49.98	1.02	1.29	0.00	0.00	0.00	1.02	1.29	0.00
1994	49.98	1.04	1.32	0.00	0.00	0.00	1.04	1.32	0.00
1995	49.98	1.06	1.35	0.00	0.00	0.00	1.06	1.35	0.00
1996	49.98	1.08	1.37	0.00	0.00	0.00	1.08	1.37	0.00
1997	49.98	1.11	1.40	0.00	0.00	0.00	1.11	1.40	0.00
1998	49.98	1.13	1.43	0.00	0.00	0.00	1.13	1.43	0.00
1999	49.98	1.15	1.46	0.00	0.00	0.00	1.15	1.46	0.00
2000	49.98	1.18	1.49	0.00	0.00	0.00	1.18	1.49	0.00
2001	49.98	1.20	1.52	0.00	0.00	0.00	1.20	1.52	0.00
2002	49.97	1.22	1.55	0.00	0.00	0.00	1.22	1.55	0.00
2003	49.97	1.25	1.58	0.00	0.00	0.00	1.25	1.58	0.00
2004	49.97	1.28	1.62	0.00	0.00	0.00	1.28	1.62	0.00
2005	49.97	1.30	1.65	0.00	0.00	0.00	1.30	1.65	0.00
2006	49.97	1.33	1.68	0.00	0.00	0.00	1.33	1.68	0.00
2007	49.97	1.36	1.72	0.00	0.00	0.00	1.36	1.72	0.00
2008	49.97	1.38	1.75	0.00	0.00	0.00	1.38	1.75	0.00
2009	49.97	1.41	1.79	0.00	0.00	0.00	1.41	1.79	0.00
2010	49.97	1.44	1.82	0.00	0.00	0.00	1.44	1.82	0.00
2011	49.96	1.47	1.86	0.00	0.00	0.00	1.47	1.86	0.00
2012	49.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00

Problem Number 1 Maint only vs Part Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	1.00	0.00	0.00	0.00	0.00	1.00
1993	1.02	0.00	0.00	0.00	0.00	1.02
1994	1.04	0.00	0.00	0.00	0.00	1.04
1995	1.06	0.00	0.00	0.00	0.00	1.06
1996	1.08	0.00	0.00	0.00	0.00	1.08
1997	1.11	0.00	0.00	0.00	0.00	1.11
1998	1.13	0.00	0.00	0.00	0.00	1.13
1999	1.15	0.00	0.00	0.00	0.00	1.15
2000	1.18	0.00	0.00	0.00	0.00	1.18
2001	1.20	0.00	0.00	0.00	0.00	1.20
2002	1.22	0.00	0.00	0.00	0.00	1.22
2003	1.25	0.00	0.00	0.00	0.00	1.25
2004	1.28	0.00	0.00	0.00	0.00	1.28
2005	1.30	0.00	0.00	0.00	0.00	1.30
2006	1.33	0.00	0.00	0.00	0.00	1.33
2007	1.36	0.00	0.00	0.00	0.00	1.36
2008	1.38	0.00	0.00	0.00	0.00	1.38
2009	1.41	0.00	0.00	0.00	0.00	1.41
2010	1.44	0.00	0.00	0.00	0.00	1.44
2011	1.47	0.00	0.00	0.00	0.00	1.47
2012	1.50	0.00	0.00	0.00	0.00	1.50

Problem Number 1 Maint only vs Part Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	10.36	5.42	0.16	15.94
1994	9.79	5.12	0.15	15.06
1995	9.25	4.84	0.14	14.24
1996	8.74	4.58	0.13	13.46
1997	8.26	4.33	0.12	12.72
1998	7.81	4.09	0.12	12.02
1999	7.38	3.87	0.11	11.36
2000	6.97	3.66	0.11	10.74
2001	6.59	3.46	0.10	10.15
2002	6.23	3.27	0.09	9.59
2003	5.88	3.09	0.09	9.07
2004	5.56	2.93	0.08	8.57
2005	5.25	2.77	0.08	8.10
2006	4.96	2.62	0.07	7.66
2007	4.69	2.47	0.07	7.24
2008	4.43	2.34	0.07	6.84
2009	4.19	2.21	0.06	6.46
2010	3.96	2.09	0.06	6.11
2011	3.74	1.98	0.06	5.78
2012	3.54	1.87	0.05	5.46
Total	127.60	67.02	1.93	196.54

Total Discounted User Benefits (Millions $) :	0.20
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.23
Net Present Value (Millions $) :	0.01
Benefit-Cost Ratio :	1.05

OUTPUT FOR ADT=1,500

11/28/92 11:23

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Part Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Part Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.23

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1.	Route Description: Maintenance Only	.
2.	Current Year Through ADT without Improvement (Thous.):	1.50
3.	Forecasted Through ADT without Improvement (Thous.):	2.25
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .

ROUTE DATA

1. Route Description: Rehab with Partial Upgrade .
4. Current Year Through ADT with Improvement (Thous.): 1.50
5. Forecasted Through ADT with Improvement (Thous.): 2.25
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 50
5. Accident Adjustment Factor: 5.00
6. Capacity per Lane on Major Route (vphpl): 842
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00
1993	44.95	1.53	1.94	0.00	0.00	0.00	1.53	1.94	0.00
1994	44.95	1.56	1.98	0.00	0.00	0.00	1.56	1.98	0.00
1995	44.95	1.59	2.02	0.00	0.00	0.00	1.59	2.02	0.00
1996	44.95	1.63	2.06	0.00	0.00	0.00	1.63	2.06	0.00
1997	44.95	1.66	2.10	0.00	0.00	0.00	1.66	2.10	0.00
1998	44.94	1.69	2.15	0.00	0.00	0.00	1.69	2.15	0.00
1999	44.94	1.73	2.19	0.00	0.00	0.00	1.73	2.19	0.00
2000	44.94	1.76	2.24	0.00	0.00	0.00	1.76	2.24	0.00
2001	44.94	1.80	2.28	0.00	0.00	0.00	1.80	2.28	0.00
2002	44.93	1.84	2.33	0.00	0.00	0.00	1.84	2.33	0.00
2003	44.93	1.87	2.38	0.00	0.00	0.00	1.87	2.38	0.00
2004	44.93	1.91	2.42	0.00	0.00	0.00	1.91	2.42	0.00
2005	44.93	1.95	2.47	0.00	0.00	0.00	1.95	2.47	0.00
2006	44.92	1.99	2.52	0.00	0.00	0.00	1.99	2.52	0.00
2007	44.92	2.03	2.58	0.00	0.00	0.00	2.03	2.58	0.00
2008	44.92	2.07	2.63	0.00	0.00	0.00	2.07	2.63	0.00
2009	44.91	2.12	2.68	0.00	0.00	0.00	2.12	2.68	0.00
2010	44.91	2.16	2.74	0.00	0.00	0.00	2.16	2.74	0.00
2011	44.91	2.20	2.79	0.00	0.00	0.00	2.20	2.79	0.00
2012	44.90	2.25	2.85	0.00	0.00	0.00	2.25	2.85	0.00

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	49.96	1.53	1.94	0.00	0.00	0.00	1.53	1.94	0.00
1994	49.96	1.56	1.98	0.00	0.00	0.00	1.56	1.98	0.00
1995	49.96	1.59	2.02	0.00	0.00	0.00	1.59	2.02	0.00
1996	49.96	1.63	2.06	0.00	0.00	0.00	1.63	2.06	0.00
1997	49.95	1.66	2.10	0.00	0.00	0.00	1.66	2.10	0.00
1998	49.95	1.69	2.15	0.00	0.00	0.00	1.69	2.15	0.00
1999	49.95	1.73	2.19	0.00	0.00	0.00	1.73	2.19	0.00
2000	49.95	1.76	2.24	0.00	0.00	0.00	1.76	2.24	0.00
2001	49.95	1.80	2.28	0.00	0.00	0.00	1.80	2.28	0.00
2002	49.94	1.84	2.33	0.00	0.00	0.00	1.84	2.33	0.00
2003	49.94	1.87	2.38	0.00	0.00	0.00	1.87	2.38	0.00
2004	49.94	1.91	2.42	0.00	0.00	0.00	1.91	2.42	0.00
2005	49.94	1.95	2.47	0.00	0.00	0.00	1.95	2.47	0.00
2006	49.93	1.99	2.52	0.00	0.00	0.00	1.99	2.52	0.00
2007	49.93	2.03	2.58	0.00	0.00	0.00	2.03	2.58	0.00
2008	49.93	2.07	2.63	0.00	0.00	0.00	2.07	2.63	0.00
2009	49.92	2.12	2.68	0.00	0.00	0.00	2.12	2.68	0.00
2010	49.92	2.16	2.74	0.00	0.00	0.00	2.16	2.74	0.00
2011	49.92	2.20	2.79	0.00	0.00	0.00	2.20	2.79	0.00
2012	49.91	2.25	2.85	0.00	0.00	0.00	2.25	2.85	0.00

Problem Number 1 Maint only vs Part Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	1.50	0.00	0.00	0.00	0.00	1.50
1993	1.53	0.00	0.00	0.00	0.00	1.53
1994	1.56	0.00	0.00	0.00	0.00	1.56
1995	1.59	0.00	0.00	0.00	0.00	1.59
1996	1.63	0.00	0.00	0.00	0.00	1.63
1997	1.66	0.00	0.00	0.00	0.00	1.66
1998	1.69	0.00	0.00	0.00	0.00	1.69
1999	1.73	0.00	0.00	0.00	0.00	1.73
2000	1.76	0.00	0.00	0.00	0.00	1.76
2001	1.80	0.00	0.00	0.00	0.00	1.80
2002	1.84	0.00	0.00	0.00	0.00	1.84
2003	1.87	0.00	0.00	0.00	0.00	1.87
2004	1.91	0.00	0.00	0.00	0.00	1.91
2005	1.95	0.00	0.00	0.00	0.00	1.95
2006	1.99	0.00	0.00	0.00	0.00	1.99
2007	2.03	0.00	0.00	0.00	0.00	2.03
2008	2.07	0.00	0.00	0.00	0.00	2.07
2009	2.12	0.00	0.00	0.00	0.00	2.12
2010	2.16	0.00	0.00	0.00	0.00	2.16
2011	2.20	0.00	0.00	0.00	0.00	2.20
2012	2.25	0.00	0.00	0.00	0.00	2.25

Problem Number 1 Maint only vs Part Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	15.57	8.25	0.23	24.05
1994	14.72	7.80	0.22	22.74
1995	13.91	7.38	0.21	21.49
1996	13.14	6.98	0.20	20.32
1997	12.42	6.60	0.19	19.21
1998	11.74	6.24	0.18	18.15
1999	11.09	5.90	0.17	17.16
2000	10.48	5.58	0.16	16.22
2001	9.91	5.28	0.15	15.34
2002	9.36	5.00	0.14	14.50
2003	8.85	4.73	0.13	13.71
2004	8.36	4.47	0.13	12.96
2005	7.90	4.23	0.12	12.25
2006	7.47	4.00	0.11	11.58
2007	7.06	3.78	0.11	10.95
2008	6.67	3.58	0.10	10.35
2009	6.30	3.39	0.09	9.79
2010	5.96	3.20	0.09	9.25
2011	5.63	3.03	0.08	8.75
2012	5.32	2.87	0.08	8.27
Total	191.85	102.29	2.89	297.03

Total Discounted User Benefits (Millions $) :	0.30
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.23
Net Present Value (Millions $) :	0.11
Benefit-Cost Ratio :	1.49

OUTPUT FOR ADT=2,000

11/28/92 11:27

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Part Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Part Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.23

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1.	Route Description: Maintenance Only	.
2.	Current Year Through ADT without Improvement (Thous.):	2.00
3.	Forecasted Through ADT without Improvement (Thous.):	3.00
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .

ROUTE DATA

1. Route Description: Rehab with Partial Upgrade .
4. Current Year Through ADT with Improvement (Thous.): 2.00
5. Forecasted Through ADT with Improvement (Thous.): 3.00
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 50
5. Accident Adjustment Factor: 5.00
6. Capacity per Lane on Major Route (vphpl): 842
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Part Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.92	2.00	2.53	0.00	0.00	0.00	2.00	2.53	0.00
1993	44.92	2.04	2.59	0.00	0.00	0.00	2.04	2.59	0.00
1994	44.92	2.08	2.64	0.00	0.00	0.00	2.08	2.64	0.00
1995	44.91	2.13	2.69	0.00	0.00	0.00	2.13	2.69	0.00
1996	44.91	2.17	2.75	0.00	0.00	0.00	2.17	2.75	0.00
1997	44.90	2.21	2.80	0.00	0.00	0.00	2.21	2.80	0.00
1998	44.90	2.26	2.86	0.00	0.00	0.00	2.26	2.86	0.00
1999	44.90	2.30	2.92	0.00	0.00	0.00	2.30	2.92	0.00
2000	44.89	2.35	2.98	0.00	0.00	0.00	2.35	2.98	0.00
2001	44.89	2.40	3.04	0.00	0.00	0.00	2.40	3.04	0.00
2002	44.88	2.45	3.10	0.00	0.00	0.00	2.45	3.10	0.00
2003	44.88	2.50	3.17	0.00	0.00	0.00	2.50	3.17	0.00
2004	44.87	2.55	3.23	0.00	0.00	0.00	2.55	3.23	0.00
2005	44.87	2.60	3.30	0.00	0.00	0.00	2.60	3.30	0.00
2006	44.86	2.66	3.37	0.00	0.00	0.00	2.66	3.37	0.00
2007	44.86	2.71	3.43	0.00	0.00	0.00	2.71	3.43	0.00
2008	44.85	2.77	3.50	0.00	0.00	0.00	2.77	3.50	0.00
2009	44.84	2.82	3.58	0.00	0.00	0.00	2.82	3.58	0.00
2010	44.84	2.88	3.65	0.00	0.00	0.00	2.88	3.65	0.00
2011	44.83	2.94	3.72	0.00	0.00	0.00	2.94	3.72	0.00
2012	44.82	3.00	3.80	0.00	0.00	0.00	3.00	3.80	0.00

Problem Number 1 Maint only vs Part Upgrade .
PROPOSED Route Rehab with Partial Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	49.93	2.04	2.59	0.00	0.00	0.00	2.04	2.59	0.00
1994	49.93	2.08	2.64	0.00	0.00	0.00	2.08	2.64	0.00
1995	49.92	2.13	2.69	0.00	0.00	0.00	2.13	2.69	0.00
1996	49.92	2.17	2.75	0.00	0.00	0.00	2.17	2.75	0.00
1997	49.92	2.21	2.80	0.00	0.00	0.00	2.21	2.80	0.00
1998	49.91	2.26	2.86	0.00	0.00	0.00	2.26	2.86	0.00
1999	49.91	2.30	2.92	0.00	0.00	0.00	2.30	2.92	0.00
2000	49.91	2.35	2.98	0.00	0.00	0.00	2.35	2.98	0.00
2001	49.90	2.40	3.04	0.00	0.00	0.00	2.40	3.04	0.00
2002	49.90	2.45	3.10	0.00	0.00	0.00	2.45	3.10	0.00
2003	49.89	2.50	3.17	0.00	0.00	0.00	2.50	3.17	0.00
2004	49.89	2.55	3.23	0.00	0.00	0.00	2.55	3.23	0.00
2005	49.89	2.60	3.30	0.00	0.00	0.00	2.60	3.30	0.00
2006	49.88	2.66	3.37	0.00	0.00	0.00	2.66	3.37	0.00
2007	49.88	2.71	3.43	0.00	0.00	0.00	2.71	3.43	0.00
2008	49.87	2.77	3.50	0.00	0.00	0.00	2.77	3.50	0.00
2009	49.87	2.82	3.58	0.00	0.00	0.00	2.82	3.58	0.00
2010	49.86	2.88	3.65	0.00	0.00	0.00	2.88	3.65	0.00
2011	49.85	2.94	3.72	0.00	0.00	0.00	2.94	3.72	0.00
2012	49.85	3.00	3.80	0.00	0.00	0.00	3.00	3.80	0.00

Problem Number 1 Maint only vs Part Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	2.00	0.00	0.00	0.00	0.00	2.00
1993	2.04	0.00	0.00	0.00	0.00	2.04
1994	2.08	0.00	0.00	0.00	0.00	2.08
1995	2.13	0.00	0.00	0.00	0.00	2.13
1996	2.17	0.00	0.00	0.00	0.00	2.17
1997	2.21	0.00	0.00	0.00	0.00	2.21
1998	2.26	0.00	0.00	0.00	0.00	2.26
1999	2.30	0.00	0.00	0.00	0.00	2.30
2000	2.35	0.00	0.00	0.00	0.00	2.35
2001	2.40	0.00	0.00	0.00	0.00	2.40
2002	2.45	0.00	0.00	0.00	0.00	2.45
2003	2.50	0.00	0.00	0.00	0.00	2.50
2004	2.55	0.00	0.00	0.00	0.00	2.55
2005	2.60	0.00	0.00	0.00	0.00	2.60
2006	2.66	0.00	0.00	0.00	0.00	2.66
2007	2.71	0.00	0.00	0.00	0.00	2.71
2008	2.77	0.00	0.00	0.00	0.00	2.77
2009	2.82	0.00	0.00	0.00	0.00	2.82
2010	2.88	0.00	0.00	0.00	0.00	2.88
2011	2.94	0.00	0.00	0.00	0.00	2.94
2012	3.00	0.00	0.00	0.00	0.00	3.00

Problem Number 1 Maint only vs Part Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	20.81	11.16	0.31	32.29
1994	19.67	10.56	0.30	30.52
1995	18.59	9.99	0.28	28.86
1996	17.57	9.45	0.26	27.28
1997	16.61	8.94	0.25	25.80
1998	15.69	8.46	0.24	24.39
1999	14.83	8.00	0.22	23.06
2000	14.02	7.57	0.21	21.80
2001	13.25	7.17	0.20	20.62
2002	12.52	6.78	0.19	19.49
2003	11.84	6.42	0.18	18.43
2004	11.19	6.07	0.17	17.43
2005	10.58	5.75	0.16	16.48
2006	10.00	5.44	0.15	15.59
2007	9.45	5.15	0.14	14.74
2008	8.93	4.87	0.13	13.94
2009	8.44	4.61	0.13	13.18
2010	7.98	4.36	0.12	12.47
2011	7.55	4.13	0.11	11.79
2012	7.13	3.91	0.11	11.15
Total	256.66	138.80	3.85	399.31

Total Discounted User Benefits (Millions $) :	0.40
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.23
Net Present Value (Millions $) :	0.21
Benefit-Cost Ratio :	1.93

APPENDIX C - SELECTED OUTPUT FOR COMPARISON OF MAINTENANCE ONLY VS REHABILITATION WITH FULL UPGRADE TO STANDARDS

OUTPUT FOR ADT=500

11/28/92 11:53

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Full Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Full Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.37

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1. Route Description: Maintenance Only .
2. Current Year Through ADT without Improvement (Thous.): 0.50
3. Forecasted Through ADT without Improvement (Thous.): 0.75
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 45
5. Accident Adjustment Factor: 9.99
6. Capacity per Lane on Major Route (vphpl): 743
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .

ROUTE DATA

1.	Route Description: Rehab with Full Upgrade	.
4.	Current Year Through ADT with Improvement (Thous.):	0.50
5.	Forecasted Through ADT with Improvement (Thous.):	0.75
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	55
5.	Accident Adjustment Factor:	1.00
6.	Capacity per Lane on Major Route (vphpl):	991
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	45.00	0.50	0.63	0.00	0.00	0.00	0.50	0.63	0.00
1993	44.99	0.51	0.65	0.00	0.00	0.00	0.51	0.65	0.00
1994	44.99	0.52	0.66	0.00	0.00	0.00	0.52	0.66	0.00
1995	44.99	0.53	0.67	0.00	0.00	0.00	0.53	0.67	0.00
1996	44.99	0.54	0.69	0.00	0.00	0.00	0.54	0.69	0.00
1997	44.99	0.55	0.70	0.00	0.00	0.00	0.55	0.70	0.00
1998	44.99	0.56	0.72	0.00	0.00	0.00	0.56	0.72	0.00
1999	44.99	0.58	0.73	0.00	0.00	0.00	0.58	0.73	0.00
2000	44.99	0.59	0.75	0.00	0.00	0.00	0.59	0.75	0.00
2001	44.99	0.60	0.76	0.00	0.00	0.00	0.60	0.76	0.00
2002	44.99	0.61	0.78	0.00	0.00	0.00	0.61	0.78	0.00
2003	44.99	0.62	0.79	0.00	0.00	0.00	0.62	0.79	0.00
2004	44.99	0.64	0.81	0.00	0.00	0.00	0.64	0.81	0.00
2005	44.99	0.65	0.82	0.00	0.00	0.00	0.65	0.82	0.00
2006	44.99	0.66	0.84	0.00	0.00	0.00	0.66	0.84	0.00
2007	44.99	0.68	0.86	0.00	0.00	0.00	0.68	0.86	0.00
2008	44.99	0.69	0.88	0.00	0.00	0.00	0.69	0.88	0.00
2009	44.99	0.71	0.89	0.00	0.00	0.00	0.71	0.89	0.00
2010	44.99	0.72	0.91	0.00	0.00	0.00	0.72	0.91	0.00
2011	44.99	0.73	0.93	0.00	0.00	0.00	0.73	0.93	0.00
2012	44.99	0.75	0.95	0.00	0.00	0.00	0.75	0.95	0.00

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	55.00	0.51	0.65	0.00	0.00	0.00	0.51	0.65	0.00
1994	55.00	0.52	0.66	0.00	0.00	0.00	0.52	0.66	0.00
1995	55.00	0.53	0.67	0.00	0.00	0.00	0.53	0.67	0.00
1996	55.00	0.54	0.69	0.00	0.00	0.00	0.54	0.69	0.00
1997	55.00	0.55	0.70	0.00	0.00	0.00	0.55	0.70	0.00
1998	55.00	0.56	0.72	0.00	0.00	0.00	0.56	0.72	0.00
1999	55.00	0.58	0.73	0.00	0.00	0.00	0.58	0.73	0.00
2000	55.00	0.59	0.75	0.00	0.00	0.00	0.59	0.75	0.00
2001	55.00	0.60	0.76	0.00	0.00	0.00	0.60	0.76	0.00
2002	54.99	0.61	0.78	0.00	0.00	0.00	0.61	0.78	0.00
2003	54.99	0.62	0.79	0.00	0.00	0.00	0.62	0.79	0.00
2004	54.99	0.64	0.81	0.00	0.00	0.00	0.64	0.81	0.00
2005	54.99	0.65	0.82	0.00	0.00	0.00	0.65	0.82	0.00
2006	54.99	0.66	0.84	0.00	0.00	0.00	0.66	0.84	0.00
2007	54.99	0.68	0.86	0.00	0.00	0.00	0.68	0.86	0.00
2008	54.99	0.69	0.88	0.00	0.00	0.00	0.69	0.88	0.00
2009	54.99	0.71	0.89	0.00	0.00	0.00	0.71	0.89	0.00
2010	54.99	0.72	0.91	0.00	0.00	0.00	0.72	0.91	0.00
2011	54.99	0.73	0.93	0.00	0.00	0.00	0.73	0.93	0.00
2012	54.99	0.75	0.95	0.00	0.00	0.00	0.75	0.95	0.00

Problem Number 1 Maint only vs Full Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	0.50	0.00	0.00	0.00	0.00	0.50
1993	0.51	0.00	0.00	0.00	0.00	0.51
1994	0.52	0.00	0.00	0.00	0.00	0.52
1995	0.53	0.00	0.00	0.00	0.00	0.53
1996	0.54	0.00	0.00	0.00	0.00	0.54
1997	0.55	0.00	0.00	0.00	0.00	0.55
1998	0.56	0.00	0.00	0.00	0.00	0.56
1999	0.58	0.00	0.00	0.00	0.00	0.58
2000	0.59	0.00	0.00	0.00	0.00	0.59
2001	0.60	0.00	0.00	0.00	0.00	0.60
2002	0.61	0.00	0.00	0.00	0.00	0.61
2003	0.62	0.00	0.00	0.00	0.00	0.62
2004	0.64	0.00	0.00	0.00	0.00	0.64
2005	0.65	0.00	0.00	0.00	0.00	0.65
2006	0.66	0.00	0.00	0.00	0.00	0.66
2007	0.68	0.00	0.00	0.00	0.00	0.68
2008	0.69	0.00	0.00	0.00	0.00	0.69
2009	0.71	0.00	0.00	0.00	0.00	0.71
2010	0.72	0.00	0.00	0.00	0.00	0.72
2011	0.73	0.00	0.00	0.00	0.00	0.73
2012	0.75	0.00	0.00	0.00	0.00	0.75

Problem Number 1 Maint only vs Full Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	9.41	1.19	0.14	10.74
1994	8.89	1.13	0.13	10.15
1995	8.40	1.06	0.13	9.59
1996	7.94	1.01	0.12	9.07
1997	7.50	0.95	0.11	8.57
1998	7.09	0.90	0.11	8.10
1999	6.70	0.85	0.10	7.65
2000	6.33	0.81	0.09	7.23
2001	5.98	0.76	0.09	6.83
2002	5.65	0.72	0.08	6.46
2003	5.34	0.68	0.08	6.10
2004	5.05	0.65	0.08	5.77
2005	4.77	0.61	0.07	5.45
2006	4.51	0.58	0.07	5.15
2007	4.26	0.55	0.06	4.87
2008	4.02	0.52	0.06	4.60
2009	3.80	0.49	0.06	4.35
2010	3.59	0.46	0.05	4.11
2011	3.39	0.44	0.05	3.88
2012	3.21	0.42	0.05	3.67
Total	115.83	14.78	1.73	132.35

Total Discounted User Benefits (Millions $) :	0.13
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.37
Net Present Value (Millions $) :	-0.19
Benefit-Cost Ratio :	0.48

OUTPUT FOR ADT=1,000

11/28/92 11:50

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Full Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Full Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.37

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1.	Route Description: Maintenance Only	.
2.	Current Year Through ADT without Improvement (Thous.):	1.00
3.	Forecasted Through ADT without Improvement (Thous.):	1.50
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .

ROUTE DATA

1.	Route Description: Rehab with Full Upgrade	.
4.	Current Year Through ADT with Improvement (Thous.):	1.00
5.	Forecasted Through ADT with Improvement (Thous.):	1.50
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	55
5.	Accident Adjustment Factor:	1.00
6.	Capacity per Lane on Major Route (vphpl):	991
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.98	1.00	1.27	0.00	0.00	0.00	1.00	1.27	0.00
1993	44.98	1.02	1.29	0.00	0.00	0.00	1.02	1.29	0.00
1994	44.98	1.04	1.32	0.00	0.00	0.00	1.04	1.32	0.00
1995	44.98	1.06	1.35	0.00	0.00	0.00	1.06	1.35	0.00
1996	44.98	1.08	1.37	0.00	0.00	0.00	1.08	1.37	0.00
1997	44.98	1.11	1.40	0.00	0.00	0.00	1.11	1.40	0.00
1998	44.98	1.13	1.43	0.00	0.00	0.00	1.13	1.43	0.00
1999	44.97	1.15	1.46	0.00	0.00	0.00	1.15	1.46	0.00
2000	44.97	1.18	1.49	0.00	0.00	0.00	1.18	1.49	0.00
2001	44.97	1.20	1.52	0.00	0.00	0.00	1.20	1.52	0.00
2002	44.97	1.22	1.55	0.00	0.00	0.00	1.22	1.55	0.00
2003	44.97	1.25	1.58	0.00	0.00	0.00	1.25	1.58	0.00
2004	44.97	1.28	1.62	0.00	0.00	0.00	1.28	1.62	0.00
2005	44.97	1.30	1.65	0.00	0.00	0.00	1.30	1.65	0.00
2006	44.97	1.33	1.68	0.00	0.00	0.00	1.33	1.68	0.00
2007	44.96	1.36	1.72	0.00	0.00	0.00	1.36	1.72	0.00
2008	44.96	1.38	1.75	0.00	0.00	0.00	1.38	1.75	0.00
2009	44.96	1.41	1.79	0.00	0.00	0.00	1.41	1.79	0.00
2010	44.96	1.44	1.82	0.00	0.00	0.00	1.44	1.82	0.00
2011	44.96	1.47	1.86	0.00	0.00	0.00	1.47	1.86	0.00
2012	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	54.99	1.02	1.29	0.00	0.00	0.00	1.02	1.29	0.00
1994	54.99	1.04	1.32	0.00	0.00	0.00	1.04	1.32	0.00
1995	54.98	1.06	1.35	0.00	0.00	0.00	1.06	1.35	0.00
1996	54.98	1.08	1.37	0.00	0.00	0.00	1.08	1.37	0.00
1997	54.98	1.11	1.40	0.00	0.00	0.00	1.11	1.40	0.00
1998	54.98	1.13	1.43	0.00	0.00	0.00	1.13	1.43	0.00
1999	54.98	1.15	1.46	0.00	0.00	0.00	1.15	1.46	0.00
2000	54.98	1.18	1.49	0.00	0.00	0.00	1.18	1.49	0.00
2001	54.98	1.20	1.52	0.00	0.00	0.00	1.20	1.52	0.00
2002	54.98	1.22	1.55	0.00	0.00	0.00	1.22	1.55	0.00
2003	54.98	1.25	1.58	0.00	0.00	0.00	1.25	1.58	0.00
2004	54.98	1.28	1.62	0.00	0.00	0.00	1.28	1.62	0.00
2005	54.98	1.30	1.65	0.00	0.00	0.00	1.30	1.65	0.00
2006	54.98	1.33	1.68	0.00	0.00	0.00	1.33	1.68	0.00
2007	54.98	1.36	1.72	0.00	0.00	0.00	1.36	1.72	0.00
2008	54.97	1.38	1.75	0.00	0.00	0.00	1.38	1.75	0.00
2009	54.97	1.41	1.79	0.00	0.00	0.00	1.41	1.79	0.00
2010	54.97	1.44	1.82	0.00	0.00	0.00	1.44	1.82	0.00
2011	54.97	1.47	1.86	0.00	0.00	0.00	1.47	1.86	0.00
2012	54.97	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00

Problem Number 1 Maint only vs Full Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	1.00	0.00	0.00	0.00	0.00	1.00
1993	1.02	0.00	0.00	0.00	0.00	1.02
1994	1.04	0.00	0.00	0.00	0.00	1.04
1995	1.06	0.00	0.00	0.00	0.00	1.06
1996	1.08	0.00	0.00	0.00	0.00	1.08
1997	1.11	0.00	0.00	0.00	0.00	1.11
1998	1.13	0.00	0.00	0.00	0.00	1.13
1999	1.15	0.00	0.00	0.00	0.00	1.15
2000	1.18	0.00	0.00	0.00	0.00	1.18
2001	1.20	0.00	0.00	0.00	0.00	1.20
2002	1.22	0.00	0.00	0.00	0.00	1.22
2003	1.25	0.00	0.00	0.00	0.00	1.25
2004	1.28	0.00	0.00	0.00	0.00	1.28
2005	1.30	0.00	0.00	0.00	0.00	1.30
2006	1.33	0.00	0.00	0.00	0.00	1.33
2007	1.36	0.00	0.00	0.00	0.00	1.36
2008	1.38	0.00	0.00	0.00	0.00	1.38
2009	1.41	0.00	0.00	0.00	0.00	1.41
2010	1.44	0.00	0.00	0.00	0.00	1.44
2011	1.47	0.00	0.00	0.00	0.00	1.47
2012	1.50	0.00	0.00	0.00	0.00	1.50

Problem Number 1 Maint only vs Full Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	18.84	2.51	0.28	21.64
1994	17.81	2.38	0.27	20.45
1995	16.82	2.25	0.25	19.33
1996	15.90	2.13	0.24	18.27
1997	15.02	2.02	0.22	17.27
1998	14.20	1.91	0.21	16.32
1999	13.41	1.81	0.20	15.43
2000	12.68	1.72	0.19	14.58
2001	11.98	1.62	0.18	13.78
2002	11.32	1.54	0.17	13.03
2003	10.70	1.46	0.16	12.31
2004	10.11	1.38	0.15	11.64
2005	9.55	1.31	0.14	11.00
2006	9.03	1.24	0.13	10.40
2007	8.53	1.17	0.13	9.83
2008	8.06	1.11	0.12	9.29
2009	7.62	1.05	0.11	8.79
2010	7.20	1.00	0.11	8.30
2011	6.80	0.95	0.10	7.85
2012	6.43	0.90	0.10	7.42
Total	232.00	31.47	3.47	266.93

Total Discounted User Benefits (Millions $) :	0.27
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.37
Net Present Value (Millions $) :	-0.06
Benefit-Cost Ratio :	0.84

OUTPUT FOR ADT=1,500

11/28/92 11:49

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Full Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Full Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.37

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1.	Route Description: Maintenance Only	.
2.	Current Year Through ADT without Improvement (Thous.):	1.50
3.	Forecasted Through ADT without Improvement (Thous.):	2.25
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .

ROUTE DATA

1. Route Description: Rehab with Full Upgrade .
4. Current Year Through ADT with Improvement (Thous.): 1.50
5. Forecasted Through ADT with Improvement (Thous.): 2.25
6. Number of Route Segments: 1
7. Year of Forecasted ADT: 2012

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1. Segment Description: Segment Data .
2. Total Number of Lanes, Major Route: 2
3. Segment Length (miles): 1.00
4. Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy: 1
5. Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation: 1

OTHER TRAFFIC DATA

1. Major Rt Current Yr Add Local ADT (Thous.): 0.00
2. Major Rt Forecasted Add Local ADT (Thous.): 0.00
3. Percent Trucks on Major Route: 11
4. Free Flow Speed on Major Route (mph): 55
5. Accident Adjustment Factor: 1.00
6. Capacity per Lane on Major Route (vphpl): 991
7. HOV Facility Switch, 0-No HOV, 1-Yes HOV: 0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992	44.96	1.50	1.90	0.00	0.00	0.00	1.50	1.90	0.00
1993	44.95	1.53	1.94	0.00	0.00	0.00	1.53	1.94	0.00
1994	44.95	1.56	1.98	0.00	0.00	0.00	1.56	1.98	0.00
1995	44.95	1.59	2.02	0.00	0.00	0.00	1.59	2.02	0.00
1996	44.95	1.63	2.06	0.00	0.00	0.00	1.63	2.06	0.00
1997	44.95	1.66	2.10	0.00	0.00	0.00	1.66	2.10	0.00
1998	44.94	1.69	2.15	0.00	0.00	0.00	1.69	2.15	0.00
1999	44.94	1.73	2.19	0.00	0.00	0.00	1.73	2.19	0.00
2000	44.94	1.76	2.24	0.00	0.00	0.00	1.76	2.24	0.00
2001	44.94	1.80	2.28	0.00	0.00	0.00	1.80	2.28	0.00
2002	44.93	1.84	2.33	0.00	0.00	0.00	1.84	2.33	0.00
2003	44.93	1.87	2.38	0.00	0.00	0.00	1.87	2.38	0.00
2004	44.93	1.91	2.42	0.00	0.00	0.00	1.91	2.42	0.00
2005	44.93	1.95	2.47	0.00	0.00	0.00	1.95	2.47	0.00
2006	44.92	1.99	2.52	0.00	0.00	0.00	1.99	2.52	0.00
2007	44.92	2.03	2.58	0.00	0.00	0.00	2.03	2.58	0.00
2008	44.92	2.07	2.63	0.00	0.00	0.00	2.07	2.63	0.00
2009	44.91	2.12	2.68	0.00	0.00	0.00	2.12	2.68	0.00
2010	44.91	2.16	2.74	0.00	0.00	0.00	2.16	2.74	0.00
2011	44.91	2.20	2.79	0.00	0.00	0.00	2.20	2.79	0.00
2012	44.90	2.25	2.85	0.00	0.00	0.00	2.25	2.85	0.00

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route Aver. Speed (mph)	Major Route Num. Veh. (000)	Major Route Num. Pers. (000)	HOV Facility Aver. Speed (mph)	HOV Facility Num. Veh. (000)	HOV Facility Num. Pers. (000)	Combined Total Num. Veh. (000)	Combined Total Num. Pers. (000)	Minor Route Num. Veh. (000)
1992									
1993	54.97	1.53	1.94	0.00	0.00	0.00	1.53	1.94	0.00
1994	54.97	1.56	1.98	0.00	0.00	0.00	1.56	1.98	0.00
1995	54.97	1.59	2.02	0.00	0.00	0.00	1.59	2.02	0.00
1996	54.96	1.63	2.06	0.00	0.00	0.00	1.63	2.06	0.00
1997	54.96	1.66	2.10	0.00	0.00	0.00	1.66	2.10	0.00
1998	54.96	1.69	2.15	0.00	0.00	0.00	1.69	2.15	0.00
1999	54.96	1.73	2.19	0.00	0.00	0.00	1.73	2.19	0.00
2000	54.96	1.76	2.24	0.00	0.00	0.00	1.76	2.24	0.00
2001	54.96	1.80	2.28	0.00	0.00	0.00	1.80	2.28	0.00
2002	54.95	1.84	2.33	0.00	0.00	0.00	1.84	2.33	0.00
2003	54.95	1.87	2.38	0.00	0.00	0.00	1.87	2.38	0.00
2004	54.95	1.91	2.42	0.00	0.00	0.00	1.91	2.42	0.00
2005	54.95	1.95	2.47	0.00	0.00	0.00	1.95	2.47	0.00
2006	54.95	1.99	2.52	0.00	0.00	0.00	1.99	2.52	0.00
2007	54.94	2.03	2.58	0.00	0.00	0.00	2.03	2.58	0.00
2008	54.94	2.07	2.63	0.00	0.00	0.00	2.07	2.63	0.00
2009	54.94	2.12	2.68	0.00	0.00	0.00	2.12	2.68	0.00
2010	54.94	2.16	2.74	0.00	0.00	0.00	2.16	2.74	0.00
2011	54.93	2.20	2.79	0.00	0.00	0.00	2.20	2.79	0.00
2012	54.93	2.25	2.85	0.00	0.00	0.00	2.25	2.85	0.00

Problem Number 1 Maint only vs Full Upgrade .

Daily Through Traffic (Thous.)

Year	WITHOUT Improvement Existing	Alternate	Proposed	WITH Improvment Existing	Alternate	Proposed
1992	1.50	0.00	0.00	0.00	0.00	1.50
1993	1.53	0.00	0.00	0.00	0.00	1.53
1994	1.56	0.00	0.00	0.00	0.00	1.56
1995	1.59	0.00	0.00	0.00	0.00	1.59
1996	1.63	0.00	0.00	0.00	0.00	1.63
1997	1.66	0.00	0.00	0.00	0.00	1.66
1998	1.69	0.00	0.00	0.00	0.00	1.69
1999	1.73	0.00	0.00	0.00	0.00	1.73
2000	1.76	0.00	0.00	0.00	0.00	1.76
2001	1.80	0.00	0.00	0.00	0.00	1.80
2002	1.84	0.00	0.00	0.00	0.00	1.84
2003	1.87	0.00	0.00	0.00	0.00	1.87
2004	1.91	0.00	0.00	0.00	0.00	1.91
2005	1.95	0.00	0.00	0.00	0.00	1.95
2006	1.99	0.00	0.00	0.00	0.00	1.99
2007	2.03	0.00	0.00	0.00	0.00	2.03
2008	2.07	0.00	0.00	0.00	0.00	2.07
2009	2.12	0.00	0.00	0.00	0.00	2.12
2010	2.16	0.00	0.00	0.00	0.00	2.16
2011	2.20	0.00	0.00	0.00	0.00	2.20
2012	2.25	0.00	0.00	0.00	0.00	2.25

Problem Number 1 Maint only vs Full Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	28.31	3.97	0.42	32.70
1994	26.75	3.76	0.40	30.91
1995	25.28	3.56	0.38	29.22
1996	23.89	3.38	0.36	27.63
1997	22.58	3.20	0.34	26.12
1998	21.34	3.04	0.32	24.69
1999	20.17	2.88	0.30	23.35
2000	19.06	2.73	0.28	22.07
2001	18.01	2.59	0.27	20.87
2002	17.02	2.45	0.25	19.73
2003	16.09	2.33	0.24	18.65
2004	15.20	2.21	0.23	17.64
2005	14.37	2.09	0.21	16.67
2006	13.58	1.99	0.20	15.77
2007	12.83	1.88	0.19	14.91
2008	12.13	1.79	0.18	14.10
2009	11.46	1.70	0.17	13.33
2010	10.83	1.61	0.16	12.60
2011	10.24	1.53	0.15	11.92
2012	9.68	1.45	0.14	11.27
Total	348.81	50.13	5.20	404.14

Total Discounted User Benefits (Millions $) :	0.40
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.37
Net Present Value (Millions $) :	0.08
Benefit-Cost Ratio :	1.21

OUTPUT FOR ADT=2,000

11/28/92 11:47

***** H E E M III *****
REVISED HIGHWAY ECONOMIC EVALUATION MODEL
VERSION 1.0

Texas Department of Transportation (TxDOT)

Revised by the Texas Transportation Institute,
Texas A&M University System
Dr. Jeffery L. Memmott, (409) 845-9939.

Problem Number 1 Maint only vs Full Upgrade .

PROBLEM ASSUMPTIONS

1.	Problem Description:	Maint only vs Full Upgrade .
2.	Current Year:	1992
3.	Problem Number:	1
4.	Area Type (1-Rural, 2-Urban):	1
5.	Const. Cat. (1-Bypass, 2-Add Cap, 3-Intchng, 4-RR Gr Sep):	2
6.	Percent Trucks:	11
7.	Alternate Parallel Route in Analysis (1-No, 2-Yes):	1
8.	Total Construction Cost (Millions of $):	0.37

ADDITIONAL PROBLEM ASSUMPTIONS

1.	Discount Rate (%):	8
2.	Analysis Period (Years):	20
3.	Type of Traffic Growth Rate (1-Const Grwth, 2-Strght Ln):	1
4.	Year when Improvement Completed:	1993
5.	Car Value of Time per Person ($/hr):	9.52
6.	Truck Value of Time per Person ($/hr):	22.63
7.	Car Occupancy Rate:	1.30
8.	Truck Occupancy Rate:	1.00
9.	Operating Cost and Accident Cost Update Factor:	1.00

HOURLY TRAFFIC DISTRIBUTION

Hour	% of ADT During Hour	Hour	% of ADT During Hour
0- 1	0.9	12-13	6.2
1- 2	0.5	13-14	6.1
2- 3	0.5	14-15	6.2
3- 4	0.1	15-16	6.7
4- 5	0.2	16-17	7.5
5- 6	0.5	17-18	8.8
6- 7	1.9	18-19	6.5
7- 8	6.8	19-20	4.9
8- 9	7.0	20-21	3.6
9-10	5.4	21-22	4.0
10-11	5.4	22-23	2.9
11-12	5.9	23-24	1.5

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .

ROUTE DATA

1.	Route Description: Maintenance Only	.
2.	Current Year Through ADT without Improvement (Thous.):	2.00
3.	Forecasted Through ADT without Improvement (Thous.):	3.00
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	45
5.	Accident Adjustment Factor:	9.99
6.	Capacity per Lane on Major Route (vphpl):	743
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
1992	2.10	4860	2006	2.10	4860
1993	2.10	4860	2007	2.10	4860
1994	2.10	4860	2008	2.10	4860
1995	2.10	4860	2009	2.10	4860
1996	2.10	4860	2010	2.10	4860
1997	2.10	4860	2011	2.10	4860
1998	2.10	4860	2012	2.10	4860
1999	2.10	4860			
2000	2.10	4860			
2001	2.10	4860			
2002	2.10	4860			
2003	2.10	4860			
2004	2.10	4860			
2005	2.10	4860			

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .

ROUTE DATA

1.	Route Description: Rehab with Full Upgrade	.
4.	Current Year Through ADT with Improvement (Thous.):	2.00
5.	Forecasted Through ADT with Improvement (Thous.):	3.00
6.	Number of Route Segments:	1
7.	Year of Forecasted ADT:	2012

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

ROUTE SEGMENT DATA

1.	Segment Description: Segment Data	.
2.	Total Number of Lanes, Major Route:	2
3.	Segment Length (miles):	1.00
4.	Major Route Facility Type, 1-Undiv, 2-Div, 3-Frwy:	1
5.	Type of Inters/Interchg, 1-None, 2-2 Way Stop, 3-4 Way Stop, 4-Signal, 5-Simple Diamond, 6-Cloverleaf, 7-3 Level Diamond, 8-Directional, 9-RR Grade Crossing, 10-RR Grade Separation:	1

OTHER TRAFFIC DATA

1.	Major Rt Current Yr Add Local ADT (Thous.):	0.00
2.	Major Rt Forecasted Add Local ADT (Thous.):	0.00
3.	Percent Trucks on Major Route:	11
4.	Free Flow Speed on Major Route (mph):	55
5.	Accident Adjustment Factor:	1.00
6.	Capacity per Lane on Major Route (vphpl):	991
7.	HOV Facility Switch, 0-No HOV, 1-Yes HOV:	0

PAVEMENT CONDITION MAINT/REHAB COST DATA

YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)	YEAR	PVMT COND (PSI)	MAINT/ REHAB COST ($)
			2006	3.10	260
1993	3.10	260	2007	3.10	260
1994	3.10	260	2008	3.10	260
1995	3.10	260	2009	3.10	260
1996	3.10	260	2010	3.10	260
1997	3.10	260	2011	3.10	260
1998	3.10	260	2012	3.10	260
1999	3.10	260			
2000	3.10	260			
2001	3.10	260			
2002	3.10	260			
2003	3.10	260			
2004	3.10	260			
2005	3.10	260			

Problem Number 1 Maint only vs Full Upgrade .
EXISTING Route Maintenance Only .
Segment 1 Segment Data .

WITHOUT Improvement

Year	Major Route			HOV Facility			Combined Total		Minor Route
	Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	Num. Veh. (000)	Num. Pers. (000)	Num. Veh. (000)
1992	44.92	2.00	2.53	0.00	0.00	0.00	2.00	2.53	0.00
1993	44.92	2.04	2.59	0.00	0.00	0.00	2.04	2.59	0.00
1994	44.92	2.08	2.64	0.00	0.00	0.00	2.08	2.64	0.00
1995	44.91	2.13	2.69	0.00	0.00	0.00	2.13	2.69	0.00
1996	44.91	2.17	2.75	0.00	0.00	0.00	2.17	2.75	0.00
1997	44.90	2.21	2.80	0.00	0.00	0.00	2.21	2.80	0.00
1998	44.90	2.26	2.86	0.00	0.00	0.00	2.26	2.86	0.00
1999	44.90	2.30	2.92	0.00	0.00	0.00	2.30	2.92	0.00
2000	44.89	2.35	2.98	0.00	0.00	0.00	2.35	2.98	0.00
2001	44.89	2.40	3.04	0.00	0.00	0.00	2.40	3.04	0.00
2002	44.88	2.45	3.10	0.00	0.00	0.00	2.45	3.10	0.00
2003	44.88	2.50	3.17	0.00	0.00	0.00	2.50	3.17	0.00
2004	44.87	2.55	3.23	0.00	0.00	0.00	2.55	3.23	0.00
2005	44.87	2.60	3.30	0.00	0.00	0.00	2.60	3.30	0.00
2006	44.86	2.66	3.37	0.00	0.00	0.00	2.66	3.37	0.00
2007	44.86	2.71	3.43	0.00	0.00	0.00	2.71	3.43	0.00
2008	44.85	2.77	3.50	0.00	0.00	0.00	2.77	3.50	0.00
2009	44.84	2.82	3.58	0.00	0.00	0.00	2.82	3.58	0.00
2010	44.84	2.88	3.65	0.00	0.00	0.00	2.88	3.65	0.00
2011	44.83	2.94	3.72	0.00	0.00	0.00	2.94	3.72	0.00
2012	44.82	3.00	3.80	0.00	0.00	0.00	3.00	3.80	0.00

Problem Number 1 Maint only vs Full Upgrade .
PROPOSED Route Rehab with Full Upgrade .
Segment 1 Segment Data .

WITH Improvment

Year	Major Route			HOV Facility			Combined Total		Minor Route
	Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	Aver. Speed (mph)	Num. Veh. (000)	Num. Pers. (000)	Num. Veh. (000)	Num. Pers. (000)	Num. Veh. (000)
1992									
1993	54.94	2.04	2.59	0.00	0.00	0.00	2.04	2.59	0.00
1994	54.94	2.08	2.64	0.00	0.00	0.00	2.08	2.64	0.00
1995	54.94	2.13	2.69	0.00	0.00	0.00	2.13	2.69	0.00
1996	54.94	2.17	2.75	0.00	0.00	0.00	2.17	2.75	0.00
1997	54.93	2.21	2.80	0.00	0.00	0.00	2.21	2.80	0.00
1998	54.93	2.26	2.86	0.00	0.00	0.00	2.26	2.86	0.00
1999	54.93	2.30	2.92	0.00	0.00	0.00	2.30	2.92	0.00
2000	54.93	2.35	2.98	0.00	0.00	0.00	2.35	2.98	0.00
2001	54.92	2.40	3.04	0.00	0.00	0.00	2.40	3.04	0.00
2002	54.92	2.45	3.10	0.00	0.00	0.00	2.45	3.10	0.00
2003	54.92	2.50	3.17	0.00	0.00	0.00	2.50	3.17	0.00
2004	54.91	2.55	3.23	0.00	0.00	0.00	2.55	3.23	0.00
2005	54.91	2.60	3.30	0.00	0.00	0.00	2.60	3.30	0.00
2006	54.91	2.66	3.37	0.00	0.00	0.00	2.66	3.37	0.00
2007	54.90	2.71	3.43	0.00	0.00	0.00	2.71	3.43	0.00
2008	54.90	2.77	3.50	0.00	0.00	0.00	2.77	3.50	0.00
2009	54.89	2.82	3.58	0.00	0.00	0.00	2.82	3.58	0.00
2010	54.89	2.88	3.65	0.00	0.00	0.00	2.88	3.65	0.00
2011	54.88	2.94	3.72	0.00	0.00	0.00	2.94	3.72	0.00
2012	54.88	3.00	3.80	0.00	0.00	0.00	3.00	3.80	0.00

Problem Number 1 Maint only vs Full Upgrade .

Daily Through Traffic (Thous.)

	WITHOUT Improvement			WITH Improvment		
Year	Existing	Alternate	Proposed	Existing	Alternate	Proposed
1992	2.00	0.00	0.00	0.00	0.00	2.00
1993	2.04	0.00	0.00	0.00	0.00	2.04
1994	2.08	0.00	0.00	0.00	0.00	2.08
1995	2.13	0.00	0.00	0.00	0.00	2.13
1996	2.17	0.00	0.00	0.00	0.00	2.17
1997	2.21	0.00	0.00	0.00	0.00	2.21
1998	2.26	0.00	0.00	0.00	0.00	2.26
1999	2.30	0.00	0.00	0.00	0.00	2.30
2000	2.35	0.00	0.00	0.00	0.00	2.35
2001	2.40	0.00	0.00	0.00	0.00	2.40
2002	2.45	0.00	0.00	0.00	0.00	2.45
2003	2.50	0.00	0.00	0.00	0.00	2.50
2004	2.55	0.00	0.00	0.00	0.00	2.55
2005	2.60	0.00	0.00	0.00	0.00	2.60
2006	2.66	0.00	0.00	0.00	0.00	2.66
2007	2.71	0.00	0.00	0.00	0.00	2.71
2008	2.77	0.00	0.00	0.00	0.00	2.77
2009	2.82	0.00	0.00	0.00	0.00	2.82
2010	2.88	0.00	0.00	0.00	0.00	2.88
2011	2.94	0.00	0.00	0.00	0.00	2.94
2012	3.00	0.00	0.00	0.00	0.00	3.00

Problem Number 1 Maint only vs Full Upgrade .

Summary of Discounted Benefits (Thous. $)

Year	Delay Savings	Red Veh Op Cost	Red Acc Cost	Total Benefits
1992	0.00	0.00	0.00	0.00
1993	37.84	5.56	0.56	43.96
1994	35.76	5.28	0.53	41.57
1995	33.80	5.01	0.50	39.31
1996	31.94	4.75	0.48	37.17
1997	30.19	4.51	0.45	35.15
1998	28.53	4.28	0.42	33.23
1999	26.97	4.06	0.40	31.43
2000	25.49	3.85	0.38	29.72
2001	24.09	3.66	0.36	28.11
2002	22.77	3.47	0.34	26.58
2003	21.52	3.30	0.32	25.14
2004	20.34	3.13	0.30	23.78
2005	19.23	2.97	0.29	22.49
2006	18.18	2.82	0.27	21.27
2007	17.18	2.68	0.26	20.12
2008	16.24	2.54	0.24	19.03
2009	15.35	2.42	0.23	18.00
2010	14.51	2.30	0.22	17.02
2011	13.72	2.18	0.20	16.10
2012	12.97	2.07	0.19	15.23
Total	466.63	70.82	6.94	544.39

Total Discounted User Benefits (Millions $) :	0.54
Total Discounted Reduction in Maint/Rehab Costs (Millions $) :	0.05
Discounted Construction Cost (Millions $) :	0.37
Net Present Value (Millions $) :	0.22
Benefit-Cost Ratio :	1.59