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GUIDELINES FOR ESTIMATING THE TRIENNIAL BENEFITS OF KANSAS TRANSPORTATION RESEARCH AND NEW DEVELOPMENTS (K-TRAN) RESEARCH PROJECTS

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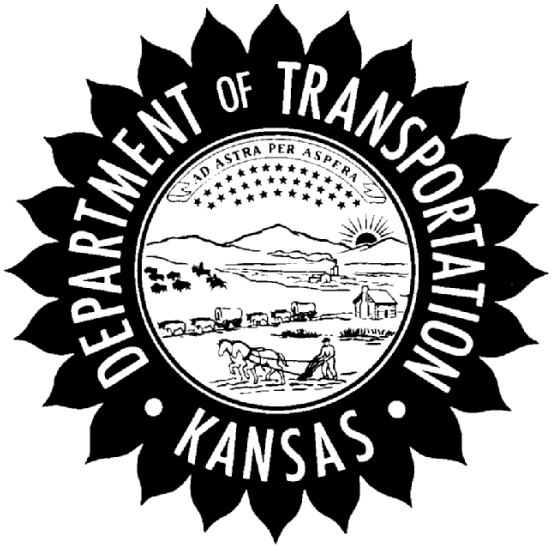

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16 Abstract
Between 1991 and 2003, the K-TRAN program has funded over 200 research projects at a total program cost of $7.3 million. Since 1991, a total of 76 K-TRAN projects have been implemented. Estimates of monetary triennial benefits have been developed by the research project monitors for 25 of the implemented projects. The estimated benefit/cost ratio for the total K-TRAN program (i.e., including projects which have not been implemented) is 15.4. The benefit/cost ratio for projects that have been or are in the process of being implemented is 37.3. The K-TRAN Program is clearly an economically viable program. The objectives of this research project were to: 1) identify and evaluate techniques for estimating the benefits of research projects, 2) test one or more of the techniques by preparing estimates of the benefits of selected completed Kansas Transportation Research and New-Developments (K-TRAN) research projects, and 3) develop and document easy to use guidelines that project monitors and principal investigators can use to develop estimates of the potential benefits of research projects. The guidelines presented in this report represent a hybrid approach to research project assessment that incorporates elements from traditional benefit-cost and multi-objective analysis techniques. The basic methodology requires the researcher to perform an initial subjective assessment of project benefits using a checklist of potential benefit categories. The researcher is then guided through a process whereby he/she is asked to attempt to quantify (i.e., assign a monetary value to) the benefits identified in the initial subjective assessment. The process provides the researcher with guidelines for developing reasonable (i.e., justifiable) estimates of potential project benefits. If the process leads to the development of a monetary estimate of benefits, then a traditional benefit-cost analysis of the project can be performed. If it is determined that the project benefits cannot be expressed in purely economic terms, then the results of the subjective multi-objective assessment are assumed to represent the best assessment possible at that point in time. The guidelines for the multi-objective assessment technique include recommendations for rating project impacts and for identifying "successful" projects based on a project's overall rating. Application of the recommended guidelines in estimating the potential monetary benefits of research projects is illustrated through an extensive set of examples using information from 14 completed K-TRAN research projects for the period 1991-2000. Current KDOT policy requires that all K-TRAN proposals and project reports include an Implementation Plan. This study recommends that this policy be expanded to require a project Benefit Assessment Plan as well.

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MANHATTAN, KANSAS

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ABSTRACT

Between 1991 and 2003, the K-TRAN program has funded over 200 research projects at a total program cost of $7.3 million. Since 1991, a total of 76 K-TRAN projects have been implemented. Estimates of monetary triennial benefits have been developed by the research project monitors for 25 of the implemented projects. The estimated benefit/cost ratio for the total K-TRAN program (i.e., including projects which have not been implemented) is 15.4. The benefit/cost ratio for projects that have been or are in the process of being implemented is 37.3. The K-TRAN Program is clearly an economically viable program. The objectives of this research project were to: 1) identify and evaluate techniques for estimating the benefits of research projects, 2) test one or more of the techniques by preparing estimates of the benefits of selected completed Kansas Transportation Research and New-Developments (K-TRAN) research projects, and 3) develop and document easy to use guidelines that project monitors and principal investigators can use to develop estimates of the potential benefits of research projects. The guidelines presented in this report represent a hybrid approach to research project assessment that incorporates elements from traditional benefit-cost and multi-objective analysis techniques. The basic methodology requires the researcher to perform an initial subjective assessment of project benefits using a checklist of potential benefit categories. The researcher is then guided through a process whereby he/she is asked to attempt to quantify (i.e., assign a monetary value to) the benefits identified in the initial subjective assessment. The process provides the researcher with guidelines for developing reasonable (i.e., justifiable) estimates of potential project benefits. If the process leads to the development of a monetary estimate of benefits, then a traditional benefit-cost analysis of the project can be performed. If it is

determined that the project benefits cannot be expressed in purely economic terms, then the results of the subjective multi-objective assessment are assumed to represent the best assessment possible at that point in time. The guidelines for the multi-objective assessment technique include recommendations for rating project impacts and for identifying "successful" projects based on a project's overall rating. Application of the recommended guidelines in estimating the potential monetary benefits of research projects is illustrated through an extensive set of examples using information from 14 completed K-TRAN research projects for the period 1991-2000. Current KDOT policy requires that all K-TRAN proposals and project reports include an Implementation Plan. This study recommends that this policy be expanded to require a project Benefit Assessment Plan as well.

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Chapter 1

Introduction

1.1 Background

The benefit-cost ratio is widely used in transportation economic analyses as a measure of economic effectiveness. The traditional benefit-cost technique consists of the following steps. First, the benefits must be determined for each implementation unit, such as mile of highway, ton of asphalt, etc. In the case of assessing the benefits of research projects, it is this initial step, the determination of the likely impacts of implementing a new procedure or process, that is frequently the most difficult. Much of the current study focused on this aspect of the problem. Next, an estimate is made of the cost of each unit of implementation. Third, an estimate is made of the period of time over which the research results are expected to be implemented and the rate of implementation in terms of implementation units per year. An adjustment can also be made for the lag in time before implementation begins. The procedure uses these inputs to estimate the net present worth or equivalent annual value of the benefits resulting from implementation of the research results. The net benefits are then divided by the project costs to obtain a benefit-cost ratio for the project.

There is an extensive body of literature dealing with benefit-cost analysis of transportation improvement projects. As a result, there is fairly general agreement within the transportation research community concerning such key variables as service lives, the discount rate, values of time and accident costs. On the other hand, there are only a limited number of studies that specifically address the estimation of the economic benefits attributable to transportation research projects.

The traditional benefit-cost approach to assessing research projects hinges on the ability to assign a dollar value to the expected benefits of the project. As noted above, this is frequently difficult to accomplish. The problem is not so much estimating the nature of the benefits, as estimating the timing and magnitude of the benefits.

In those situations where a clearly defined economic (i.e., monetary) benefit cannot be determined, a more subjective assessment procedure can be used. A subjective assessment procedure that is commonly used in these situations involves assessing the extent to which the study's objectives were achieved. In these "multi-objective" assessment procedures, the researcher assigns a numeric rating (typically in the range of 1 to 10) to indicate the degree to which a research project is likely to have a positive impact on applicable benefit categories. The problem with this subjective approach is that it is difficult to assign a meaningful measure of project "success" on the basis of the overall rating or score derived from the multi-objective analysis.

This report presents the results of a study directed at the development of guidelines for assessing the benefits of transportation research projects within the constraints of traditional benefit-cost analysis and multi-objective assessment techniques.

1.2 Problem Statement

Estimates of the benefits of research projects are needed at several stages in the research program. Researchers are required to prepare an initial estimate of the potential benefits of new research projects as part of the proposal preparation process. At the conclusion of the research project, project principal investigators and project monitors are required to submit estimates of project benefits for the three year period following implementation of the study findings.

In the research project review and selection process, members of the Kansas Transportation Research and New Developments (K-TRAN) Program Area Panels and the Research Technical Committee usually base their selection of candidate research projects on the potential benefits likely to be derived. Finally, the continued existence of the K-TRAN Program requires a clear demonstration that the benefits derived from the program exceed the program costs. Based on these considerations, there is a need for easy to use guidelines that project monitors, principal investigators and K-TRAN Area Panels can use to assess the potential benefits of K-TRAN projects.

1.3 Objectives

The objectives of this research project were to: 1) identify and evaluate techniques for estimating the benefits of transportation research projects, 2) test one or more of the techniques by preparing estimates of the benefits of selected completed K-TRAN projects, and 3) develop and document easy to use guidelines that project monitors and principal investigators can use to develop estimates of the potential benefits of research projects.

1.4 Benefits

The results of this study should be useful to principal investigators, project monitors, and Area Panel members in estimating the benefits of K-TRAN projects. The establishment of a systematic procedure for assessing the benefits of proposed and implemented research projects should greatly enhance the likelihood that research personnel will view benefit assessment as an integral component of the research process. The implementation of the guidelines presented in this report should also be useful in assessing the overall economic efficiency of the K-TRAN Program.

1.5 Study Method

The basic guidelines presented in this research report are based on a review of current KDOT procedures and a review and synthesis of information from previous research efforts in the area of assessing the benefits of transportation research projects. The Bibliography section of this report presents a complete listing of the sources consulted in the course of this research effort.

In addition to the literature review and conversations with selected KDOT personnel, the recommended guidelines are based on reviews of project benefit assessment information contained in the K-TRAN *Assessment and Implementation (A&I) Reports* and the K-TRAN *Research Implementation Plans* for approximately 75 implemented K-TRAN projects for the period 1991-2000. [Note: use of the *A&I Reports* was discontinued in 1998. Beginning in 1998, *Research Implementation Plans* were required for each completed K-TRAN project.]

Chapter 2

The K-TRAN Program

2.1 Overview

The Kansas Transportation Research and New Developments (K-TRAN) Research Program utilizes the academic and research resources of the Kansas Department of Transportation (KDOT), Kansas State University (KSU) and the University of Kansas (KU) to address the transportation needs of the State of Kansas in an ongoing, cooperative and comprehensive manner. The projects included in the research program are jointly developed by KDOT and the universities. Between 1991 and 2003, the K-TRAN program has funded over 200 research projects at a total program cost of $7.3 million. A listing of K-TRAN projects is provided in Appendix A.

2.2 Benefits of K-TRAN Program

Since 1991, a total of 76 K-TRAN projects have been implemented (See Table 1). Estimates of monetary triennial benefits have been developed by the research project monitors for 25 of the implemented projects. As shown in Table 1, the estimated benefit/cost ratio for the total K-TRAN program (i.e., including projects which have not been implemented) is 15.4. The benefit/cost ratio for projects that have been or are in the process of being implemented is 37.3. The K-TRAN Program is clearly an economically viable program.

Table 1. Implemented K-TRAN Projects
(March 2003)

K-TRAN Project No.	Report Date	Principal Investigator	Project Monitor	Research Budget	Amount Expended	Impl. Plan Date	Impl. Begin Date	Impl Comp. Date	Impl Budget	Estimated Total Cost	Product	Projected Triennial Benefit	Actual Triennial Benefit[1]	Projected B/C Ratio	Actual B/C Ratio	Comments[2]
KSU-91-2	2/1/1992	Babcock	Scheirman	$43,579	$42,951					$42,951	DE					AIR
KSU-91-5	8/1/1994	Weist, Davis	Ross	$40,749	$29,686			6/25/1997		$29,686	DE					AIR
KSU-91-6	8/1/1992	Archer	Clowers	$10,000	$10,000					$10,000	DE		$30,000		3.0	AIR
KU-91-2	10/1/1993	Darwin	Reynolds	$105,580	$105,590					$105,590	DE					IIP
KU-91-3	7/1/1992	Roddis	Gisi	$34,769	$34,769			6/7/1995		$34,769	DE		$1,200,000		34.5	AIR
KSU-92-5	10/1/1992	Kiser, Goodwin	Scheirman	$15,350	$15,350					$15,350	PO		$25,000		1.6	AIR
KSU-92-6	9/1/1993	Phillips	Scheirman	$17,700	$15,662			7/26/1995		$15,662	SO		$15,000		1.0	AIR
KSU-92-8	1/1/1992	Russell, Rys	N.Buckley	$14,942	$14,942					$14,942	PO		$9,247,048		618.9	AIR
KU-92-1	7/1/1992	McEnroe	Richardson	$35,236	$35,236					$35,236	DE		$429,000		12.2	AIR
KU-92-2	10/1/1992	Kurt	Washburn	$47,480	$47,480					$47,480	PO					AIR
KU-92-4	6/1/1993	Kurt	Carlyle	$72,480	$66,075					$66,075	SO					AIR
KU-92-5	6/1/1992	Moore	Ingram	$21,400	$21,400					$21,400	PO		$30,000,000		1401.9	AIR
KSU-93-1	5/1/1994	Stokes	Heidner	$34,980	$33,626					$33,626	PO					AIR
KSU-93-2	5/1/1994	Devore, Hossain	Parcells	$40,541	$40,387	4/1/1998	8/1/1993	10/1/1994	$37,113	$77,500	HA, SO		$30,100,000		745.3	
KSU-93-3	12/1/1993	Fan, L.T.	Smith	$8,500	$8,500					$8,500	SO		$27,000		3.2	AIR
KSU-93-4	2/1/1997	Fan	Smith	$36,000	$36,000	8/1/1998	2/1/1997	10/1/1997		$36,000	TE		$36,000		1.0	
KSU-93-5	3/1/1994	Stokes,Reddi,Russell	Bodner	$40,047	$39,800			8/15/1996		$39,800	SO					AIR
KU-93-1	1/1/1995	Cross	Steward	$92,288	$83,683			7/14/1995		$83,683	DE		$3,054,420		36.5	AIR
KU/KSU-93-2	8/1/1994	Roddis, Melhem	Risch	$59,719	$59,540	9/10/2002	8/1/1994	7/1/1995		$59,540	SO					
KU-93-4	6/1/1994	McEnroe	Gisi	$29,500	$29,500	8/1/1998	8/1/1994	8/1/1998		$29,500	DE, SO					
KU-93-5	7/1/1993	McEnroe	Richardson	$29,000	$29,012			6/10/1996		$29,012	DE		$450,000		15.5	AIR
KU-93-6	12/1/1994	Moore	Gisi	$25,000	$25,000			6/7/1995		$25,000	PO					AIR
KSU-94-1	12/1/1994	Stunkel	Marion	$20,000	$19,107			7/15/1997		$19,107	PO					AIR
KSU-94-4	NRN	Stokes, Russell	Tobaben	$42,355	$42,355	8/1/1998	6/1/1998	8/1/1998		$42,355	DE					
KSU/KU-94-2	2/1/1996	Russell,Ewy,Smith,Mulinazzi,L	Gilliland	$90,000	$82,292			7/9/1997		$82,292	PO					AIR
KU-94-2	11/1/1996	Moore	G.N. Clark	$85,000	$84,220			7/15/1997		$84,220	DE		$4,726,000		56.1	AIR
KU-94-4	6/1/1994	McEnroe	Richardson	$19,500	$19,500			6/1/1994		$19,500	DE					AIR
KU-94-5	12/1/1996	Parr	Reynolds	$30,000	$29,860			7/8/1997		$29,860	SO		$45,000		1.5	AIR
KU/KSU-94-3	8/1/1994	Kurt, Stokes, et al	Gudenkauf	$52,407	$51,334	7/31/1998	8/1/1994	8/1/1998	$545,430	$596,764	PO					
KSU-95-2	7/1/1996	Hossain	Cushing	$27,991	$29,433					$29,433	PO					AIR
KSU-95-3	2/1/1996	Babcock, et al.	Racine	$45,000	$45,000					$45,000	PO					AIR
KSU-95-5	5/1/1996	Stokes, Russell	S. Buckley	$40,000	$41,089	8/1/1998	10/1/1998			$41,089	DE, SO		$90,000		2.2	IIP (?)
KSU-95-7	12/1/1998	Hossain	La Torella	$41,985	$41,843	7/22/1999	8/1/1998	12/15/1998		$41,843	HA		$12,000		0.3	
KSU-95-8	9/1/1996	Babcock	Cushing	$25,000	$25,000	7/8/1997	6/1/1997	7/1/1997		$25,000	---					Phase I of KSU-96-5
KU-95-1	6/1/1995	McEnroe	Younger	$29,500	$29,500		6/5/1995	6/11/1996		$29,500	DE		$125,000		4.2	AIR
KU-95-3	NRN	Belcher, Rock	Voss	$17,950	$17,776					$17,776	PO		$1,500		0.1	AIR
KU-95-4	4/1/1996	Cross	Fager	$45,000	$44,985					$44,985	DE		$324,000		7.2	AIR
KU-95-5	10/1/1996	Buress	Sloop	$49,892	$65,562	7/1/1998	10/1/1996	10/1/1997		$65,562	PO					
KU-95-7	4/1/1997	Roddis	Stock	$28,000	$27,887	8/10/1999	4/1/1999			$27,887	SO					IIP, follow-up study to begin 2005
KU/KSU-95-8	2/1/1996	Roddis, Melhem	Risch	$10,400	$20,800	7/15/1998	7/1/1997	2/1/2001		$20,800	SO					
KSU-96-3	8/1/1998	Russell/Stokes	Roadifer	$40,000	$39,689	8/1/2000	8/1/1998	8/1/1999		$39,689	SO					
KSU-96-5	9/1/1996	Babcock	Cushing	$9,500	$8,662	7/8/1997	6/1/1997	7/1/1997		$8,662	PO					(see KSU-95-8)
KSU-96-6	5/1/1997	Rys/Russell	Everhart	$35,000	$30,587	8/31/2000	8/1/1999			$30,587	DE					DM
KSU-96-9	7/1/1997	Babcock/Russell	Rosacker	$10,345	$9,448	10/14/2002	8/1/1997	12/1/1999		$9,448	DE, PO		$9,000,000		952.6	
KSU-96-10	12/1/1999	Russell	McReynolds	$7,171	$6,217	7/21/2000	12/1/1999	7/1/2000		$6,217	TR					
KU-96-2	12/1/1997	Kindscher.Mehaffey,Fraser	Herin	$39,000	$27,649	8/22/2000	12/1/1997	8/22/2000		$27,649	DE, PO					
KU-96-3	4/1/1999	Roddis/Kriesten/Liu	Niehaus	$19,600	$19,600	7/26/2000	1/15/2000	10/15/2000	$2,000	$21,600	DE, SO					Phase I of KU-00-3
KU-96-6	1/1/1998	Cross	Maag	$37,500	$37,500	7/1/1998	8/1/1998	10/15/2000		$37,500	DE		$100,000		2.7	
KU-96-7	1/1/1998	McEnroe	Younger	$49,900	$49,550	9/17/1999	10/1/1999	6/1/2000		$49,550	SO					
KSU-97-1	10/1/1999	Mutabazi,Russell,Stokes	S.King	$32,250	$32,820	8/30/2002	10/1/1999	11/1/1999		$32,820	DE, PO					
KSU-97-2	4/1/1998	Stokes/Russell	Thornburgh	$45,000	$4,652	8/26/2002	6/1/1998	12/1/2001	$200,000	$204,652	PO					
KSU-97-6	1/15/2002	Hossain / Wu	Gisi	$30,000	$29,934	9/4/2002	7/1/2002	11/1/2002		$29,934	DE					
KSU-97-7	4/1/1999	Melhem/Russell/Smith	Everhart	$22,750	$22,750	8/27/1999	10/1/1999	6/1/2000		$22,750	DE					
KU-97-2	12/1/1997	McEnroe	Richardson	$35,000	$17,485	8/1/1998	4/1/1998	9/4/2001		$17,485	DE, PO					
KU-97-3	1/1/1999	Burress	Slimmer	$24,000	$23,724	2/19/2003	1/1/1999	5/10/1999		$23,724	PO					
KU-97-4	5/1/2000	Parr	Reynolds	$30,000	$28,025	1/13/2003	5/1/2000	6/1/2000		$28,025	DE					
KU-97-5	5/1/1999	Cross	Fager	$45,000	$45,000	8/10/1999	8/1/1999	10/1/1999		$45,000	DE					

Source: KDOT Bureau of Materials and Research

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(March 2003)

K-TRAN Project No.	Report Date	Principal Investigator	Project Monitor	Research Budget	Amount Expended	Impl. Plan Date	Impl. Begin Date	Impl Comp. Date	Impl Budget	Estimated Total Cost	Product	Projected Triennial Benefit	Actual Triennial Benefit[1]	Projected B/C Ratio	Actual B/C Ratio	Comments[2]
KU-97-6	12/1/1997	Darwin/Locke	T.Mutschelknaus	$33,000	$33,000	7/1/1998	7/1/1998	12/1/1999		$33,000	PO					
KSU-98-5	8/1/1998	Babcock	Armour	$30,000	$29,848	10/10/1998	7/15/1999	6/15/2000		$29,848	PO		$35,500,000		1189.4	
KSU-98-7	9/1/1998	Rys	Everhart	$22,000	$21,390	8/24/2000	4/1/2000	8/24/2000		$21,390	DE					
KU-98-1	10/1/1999	McEnroe	Reynolds	$30,000	$30,000	1/13/2003	10/1/1999			$30,000	DE					DM
KU-98-2	4/1/2000	Cross	Fager	$10,000	$9,997	8/2/2000	4/1/2000	8/30/2000		$9,997	DE					
KU-98-3	6/1/1998	McEnroe	Richardson	$10,000	$10,000	8/27/2002	6/1/1998	12/1/1998		$10,000	DE					
KU-98-4	1/1/2001	Darwin	Scherschligt	$50,000	$50,000	5/27/2002	6/1/2002	6/1/2002		$50,000	DE					
KU-98-5	5/1/2001	Cross	Fager	$51,500	$51,000	6/7/2002	4/1/2001	6/1/2001		$51,000	DE					
KU-98-8	9/1/2002	Greenfield, Roddis,Wang	Risch	$22,000	$22,000	12/9/2002	9/1/2002	12/1/2002	$1,000	$23,000	SO		$10,000		0.4	
KSU-99-2	9/1/1999	Babcock	Armour	$35,000	$32,482	8/2/2000	9/1/1999	8/2/2000		$32,482	PO					
KSU-99-6	9/1/2001	Russell / Brondell	Stodgell	$33,250	$32,743	9/10/2002	10/1/2001	12/1/2001		$32,743	PO					
KU-99-1	9/1/1999	McEnroe/Wade/Smith	Richardson	$35,000	$35,000	9/5/2001	3/16/2000			$35,000	DE		$89,000		2.5	DM
KU-99-5	8/1/2001	McEnroe / Zhao	Reynolds	$35,000	$34,958	1/13/2003	8/1/2001			$34,958	DE					DM
KU-99-6	5/1/2000	Darwin/Locke	Scherschligt	$39,000	$39,000	5/1/2000	6/1/2000	6/1/2000		$39,000	DE					
KSU-00-3	10/1/2001	Russell/Landman/Mukherjee	Schwartz	$35,000	$34,745	2/22/2003	10/1/2001	12/1/2001		$34,745	DE					
KU-00-3	8/1/2002	Roddis/Kulseth/Liu	J. Jones	$21,300	$21,300	7/26/2000	8/1/2002	8/31/2002	$4,000	$25,300	DE, SO		$570,000		12.2	(see KU-96-3)
KU-00-6	1/1/2001	Parsons/Johnson/Cross	Hunt	$39,000	$39,000	9/16/2002	5/1/2000	7/1/2000		$39,000	DE					
KU-00-7	2/1/2002	Meyer / Walton	Volz	$35,000	$34,778	11/1/2002	2/1/2002	1/31/2003		$34,778	PO					
KU-00-9	9/1/2000	Parr	Rognlie	$30,000	$30,037	8/2/2002	9/1/2000			$30,037	DE					IIP
Totals									$789,543	$3,355,845		$0	$125,205,968			

Product Key		Benefit & Comments Key	
HA = Hardware/Physical Product		N/A	Not Available
SO = Software		AIR	Assessment and Implementation Report
PO = Policy Study		IIP	Implementation in Progress
DE = Design/Evaluation Procedure		RIP	Research Implementation Plan
TE = Test Method		DM	publication in design manual will complete implementation.
TR = Training Material			

Benefit Cost Ratio	
B/C for Total K-TRAN Program	15.4
B/C for Complete Implemented, and Implementation in Progress Projects	37.3

Notes:
1. Actual triennial benefit as reported by project monitors.
2. All listed projects have completed research implementation plans on file except those denoted "AIR" and "RIP pending".

FY	Annual Program Amounts
1991	$376,596
1992	$409,618
1993	$487,430
1994	$512,191
1995	$505,121
1996	$516,851
1997	$497,353
1998	$504,000
1999	$500,460
2000	$805,550
2001	$740,200
2002	$740,000
2003	$739,097
total	$7,334,467

Source: KDOT Bureau of Materials and Research

Chapter 3

Guidelines for Estimating the Benefits of K-TRAN Research Projects

3.1 Overview

The review of previous research efforts identified two basic approaches for assessing the benefits of transportation improvement and research projects. The first approach is applicable when the economic impacts (benefits and costs) of transportation research projects can be expressed primarily in monetary terms. In this case, traditional benefit-cost techniques can be used to assess the economic effectiveness of the project.

The second basic approach is applicable to those cases where project benefits cannot be expressed in strictly monetary terms. In these situations, project benefits are assigned numeric ratings that reflect how well the research results satisfied the study objectives. This basic approach is commonly referred to as "multi-objective" analysis.

Several forms of the multi-objective analysis technique were evaluated in this research project. The various forms considered included techniques that require the analyst to assign "weights" to the individual benefit impact categories, and techniques that lead to the development of a "benefit-cost effectiveness index" for each research project. The "benefit-cost effectiveness index" is calculated by dividing the sum of the ratings assigned to each of the factors affected by the research project by the cost of the research project. Since this index is obtained by dividing an index number (i.e., impact category rating) by a dollar cost value, it is not a particularly meaningful stand alone measure of research project effectiveness. As a result, it was determined by the research team that assigning a simple (i.e., non-weighted) numeric rating to the individual impact factors produced a more meaningful and understandable

assessment of overall project success than more elaborate measures such as composite benefit indices.

The multi-objective assessment technique recommended in this study is a modified version of the multi-objective assessment procedure that was used by KDOT as part of the department's K-TRAN Research Assessment and Implementation (A&I) reporting process until 1998. This multi-objective assessment technique is based in large part on the work of Tavakoli and Collyard (1992).

The guidelines presented in this report represent a hybrid approach to research project assessment that incorporates elements from traditional benefit-cost and multi-objective analysis techniques. The basic methodology requires the researcher to perform an initial subjective assessment of project benefits using a checklist of potential benefit categories. The researcher is then guided through a process whereby he/she is asked to attempt to quantify (i.e., assign a monetary value to) the benefits identified in the initial subjective assessment. The process provides the researcher with guidelines for developing a range of possible impact values. This process is intended to lead to the development of a "reasonable"(i.e., "justifiable") estimate of potential project benefits expressed in monetary terms. If the process leads to the development of a monetary estimate of benefits, then a traditional benefit-cost analysis of the project can be performed. If it is determined that the project benefits cannot be expressed in purely economic terms, then the results of the subjective multi-objective assessment are assumed to represent the best assessment possible at that point in time.

The guidelines for the multi-objective assessment technique include recommendations for rating project impacts and for identifying "successful" projects based on a project's overall rating.

The recommended assessment guidelines are presented in the following section of this report. Application of the guidelines is illustrated through an extensive set of examples using information from nearly 75 K-TRAN research projects for the period 1991-2000.

> ***The intent of the guidelines and the accompanying example applications is to illustrate that, based on a careful and thoughtful examination of research project results, K-TRAN researchers and project monitors should be able to arrive at reasonable (i.e., "justifiable") estimates of the monetary benefits that could be achieved if the research results were to be implemented.***

3.2 Summary of Recommended Guidelines

The recommended guidelines for estimating the triennial benefits of K-TRAN research projects consist of the following basic steps.

Step 1: Determine if research findings can be implemented.

The project principal investigator(s) and the KDOT Project Monitor should review the completed research and determine what (if any) of the research findings can be implemented. The *KDOT Research Project Implementation Plan* forms provided in Appendix B should be used to complete this Step. If it is determined that the research findings will be implemented, the analyst should proceed to Step 2 of the recommended assessment process. If it is determined that none of the research findings can be implemented (i.e., the research has no benefits), this information should be recorded on the *K-TRAN Research Project Implementation Progress Report Form* (see Appendix B). If it is determined that the research has no benefits, the project assessment process can be concluded at this point.

Step 2: Identify benefit impact areas affected by the research project.

The project principal investigator(s) and the KDOT Project Monitor should review the check list of potential benefit categories shown in Part F of the *KDOT Research Project Implementation*

Plan forms provided in Appendix B and identify those that are applicable to the research project being evaluated. As part of this phase of the process, the project principal investigator(s) and the KDOT Project Monitor should also consider the potential "beneficiaries" of the research effort. In many cases, KDOT will be the primary beneficiary, but the potential impacts of the research on other state and local agencies should not be overlooked.

Step 3: Assign a numeric rating to the applicable benefit categories.

The principal investigator(s) and the KDOT Project Monitor should review the objectives of the research project and assign a numeric rating to indicate the potential significance of the research results in terms of the applicable impact factors. The applicable benefit categories (see Part F of the *KDOT Research Project Implementation Plan* forms provided in Appendix B) should be rated from 1 to 10, with 10 representing the most significant positive benefit. The following guidelines for selecting an appropriate numeric rating are suggested: NA = factor does not apply to this project; 0 = absolutely no benefit; 1 = intuitive feeling that the project has some slight benefit; 5 = no clear evidence but strong subjective feeling that the project has a significant positive benefit; 10 = clear evidence or strong feeling the project has an excellent to outstanding, positive benefit.

This study recommends that research projects be considered "successful" (i.e., cost effective) if they receive a rating of "5" in at least one of the impact categories listed in Part F of the *KDOT Research Project Implementation Plan* forms provided in Appendix B. Principal investigators and project monitors should consider this criterion when assigning numeric ratings to the impact factors.

Step 4: Document the results of Steps 2 and 3.

The basis for the ratings assigned to the benefit categories in Step 3 should be fully documented.

This is an important step in the assessment process in that the documentation may provide useful guidance in identifying potential monetary impacts of the research (see Step 5). The documentation should also identify the potential beneficiaries of the research (KDOT, cities, counties, motorists, the business community, etc.), the geographic scope of the potential impacts of the research (national, statewide, local, etc.), and the likely timing of the benefits (immediate, 5 years from now, 10 years from now, etc.). In this step, the principal investigator and the project monitor should strive to "quantify" to the extent possible the rationale behind the numeric ratings assigned to the benefit impact factors in Part F of the *KDOT Research Project Implementation Plan* forms provided in Appendix B.

Step 5: Estimate the potential economic impacts of the research.

In many cases, this will be the most difficult phase of the assessment process. However, if the basis for the benefit category ratings established in Step 3 is carefully documented, it should be possible in many cases to develop a range of estimates of potential economic impacts. For example, if it is determined in Step 2 that the research could lead to a travel time savings for motorists, information on current traffic volumes and generally accepted values of time (see Appendix C) could be used to estimate the potential economic impacts of the research.

In attempting to quantify the economic benefits of a research project, the principal investigator and the project monitor should brainstorm on the implications of a range of potential strategies concerning the implementation of the research results. For example, the principal investigator and the project monitor should initiate the brainstorming by addressing the following basic questions.

- Does the research propose (or imply) changes in existing policy, standards, or practice?
- If the research proposes changes in existing policy, standards, or practice,

how soon could the research findings be implemented?

- If the research proposes changes in existing policy, standards, or practice, what would be the scope of the changes in terms of agencies and geographic areas affected?
- If the research proposes changes in existing policy, standards, or practice, are there specific agencies and/or project sites where the research results could be evaluated?
- Does the research provide any evidence concerning the potential magnitude of the impacts of the proposed changes?
- Does the research provide any evidence concerning the potential magnitude of the economic impacts of the proposed changes?

The goal of the brainstorming should be to arrive at a reasonable estimate(s) of the potential economic impacts of the research project. As suggested by the questions listed above, this process should begin by determining the implementation potentials of the research findings. If the research findings have the potential for immediate implementation, the agencies (KDOT Bureaus, counties, cities, etc.) and geographic areas (statewide, selected sites, etc.) affected by the implementation need to be identified. By clearly identifying the agencies and geographic areas affected by the research findings it may be possible to identify a specific agency office, project site or case study to serve as a basis for assessing the economic impacts of implementing the research findings. In the ideal situation, evidence from the research project concerning the potential magnitude of the impacts that could be expected if the research findings are implemented could be applied to the project site or case study conditions. If it is not possible to identify a project site or case study, or if evidence is not available from the research project concerning the potential magnitude of the impacts that could be expected if the research findings are implemented, a more generic "what if" approach may be needed. This approach is outlined

below.

Clearly, the development of precise estimates of economic impacts is not possible in all situations. In such cases, the principal investigator and the project monitor are encouraged to take a "what if" approach in attempting to estimate the potential economic impacts of research projects. This approach could involve assessing the economic impacts of a range of "what if" scenarios concerning implementation of research findings. An example of this approach can be found in K-TRAN Study KSU-97-5. That study examined the susceptibility of different geologic formations to slope failure and suggested general guidelines to predict slope failures. In assessing the economic benefits of the research, the principal investigator suggested that "***if*** the study prevents 1 slope failure, the resulting savings would be $120,000 over a 3 year period." A similar approach was taken in K-TRAN Study KU-97-2. In that study the researchers were asked to develop practical guidance for the design and implementation of temporary erosion control measures. In assessing the potential benefits of the research project, the principal investigator noted that "in 1996, total dollar bids for temporary ditch checks and temporary slope barriers for KDOT projects were $2,950,900". The principal investigator suggested that "***if*** the study findings resulted in a 10 percent reduction in the required temporary erosion measures, potential savings of $295,000 per year could be realized".

[***Note: K-TRAN Studies 97-5 and 97-2 referenced above have not been implemented. The intent of the discussion of these projects is to illustrate the "what if", brainstorming approach to identifying benefits that may result from project implementation.***]

If the principal investigator and the project monitor are able to arrive at a reasonable estimate of the economic benefits of the research project, the benefits should be reported in terms of a triennial (3-year) value. Given the relatively short time frame (i.e., 3 years) and the

approximate nature of the estimated benefits, it is recommended that the annual benefits not be adjusted to account for the effects of compounding over the 3 year period (i.e., triennial benefits = annual benefits x 3). The estimated benefits should be documented and recorded in the "projected" or "actual" triennial benefits cells of the *Research Project Implementation Progress Report* provided in Appendix B.

Much of the discussion to this point has addressed research studies that could result in benefits that would be realized in a relatively short time frame following implementation. However, research findings with benefits that may not be realized until 10- 20 years into the future should not be ignored when estimating current (triennial) benefits. To illustrate this point, consider the results from K-TRAN Study KU-94-1. The objectives of that study were to determine the potential factors contributing to bridge deck cracking and to recommend procedures to alleviate the problem. The study concluded that if the study findings were implemented the department would realize a savings of $1.4 million per year beginning 15 years from the time the study findings are implemented. This "future benefit" can be expressed as an equivalent present value and used to estimate the triennial benefits of the research.

If the principal investigator and the project monitor are unable to assign a monetary value to the potential benefits of the research project, the results of the subjective multi-objective assessment completed in Steps 2-4 can be assumed to represent the best assessment possible at that point in time.

Step 6: Document the results of the assessment process. The results of the assessment process should be fully documented. The documentation should include the results of the multi-objective assessment and a discussion of the basis for the numeric ratings assigned to each of the applicable benefit factors. If estimates of the economic impacts of the research are developed,

data sources and all assumptions should be clearly documented in the Forms provided in Appendix B.

3.3 Estimating Economic Benefits: Example Applications

This section of this report illustrates the application of the "Recommended Guidelines" through a set of examples that draw upon information reported in selected *A&I* and *Research Implementation Plans* for the period 1991-2000. Because it is frequently the most difficult phase of the assessment process, the examples focus on estimating the economic (monetary) benefits of research projects.

> ***The intent of the example applications is to illustrate that, based on a careful and thoughtful examination of research project results, K-TRAN researchers and project monitors should be able to arrive at reasonable (i.e., "justifiable") estimates of the monetary benefits that could be achieved if the research results were to be implemented. Many of the examples represent projects that have not been implemented. As a result, the non-implemented studies do not appear in the benefit assessment data presented in Table 1 of this report.***

Example 1

K-TRAN Title:	Prototype Expert System for Resolution of Concrete Construction Problems.
K-TRAN No.:	KSU-91-1.
Study Objectives:	Development of an expert system (computer program) for use by construction staff as an aid in identifying and repairing problems that sometimes occur during the construction of bridges.
Estimated Benefits:	The project principal investigator suggests that if the software became widely distributed and was used as a training tool, expected savings of a nominal 0.1% of the triennial bridge construction budget could be expected. For the period 1995 - 97, this would be $220,000.
Study Cost:	$40,278.
Estimated B/C Ratio:	5.5:1.

Example 2

K-TRAN Title:	Studies in the Establishment of Native Woody Plants.
K-TRAN No.:	KSU-91-5.
Study Objectives:	To determine if and under what environmental and physiological conditions and cultural practices woody plants could be economically established on the roadside by direct seeding.
Estimated Benefits:	The results of this study were presented at the national meeting of the American Society for Horticultural Science and distributed to over 20 local, state and national agencies. The study clearly has a benefit in terms of technology transfer. While it is difficult to precisely quantify the benefits of this technology transfer, a benefit equal to the initial estimate of the cost of the study ($40,000) does not appear to be unreasonable.
Study Cost:	$29,686 (actual project expenditures).
Estimated B/C Ratio:	1.3:1.

Example 3

K-TRAN Title:	Evaluation of Policies on Highway Sign Materials.
K-TRAN No.:	KSU-92-8.
Study Objectives:	Determine the best, cost-effective policy, consistent with safety, for material type used on highway signs in Kansas.
Estimated Benefits:	The potential to reduce traffic crashes was determined to be the primary benefit of this research. The researchers estimated the safety benefits of the study by assuming that implementation of the study findings could result in a 1% reduction in all traffic crashes on the state highway system for the period 1991-93 (63,842 crashes). The researchers assumed the average cost of a traffic crash to be $20,777. Based on these assumptions, the estimated triennial benefit is approximately $13,270,000.
Study Cost:	$14,942.
Estimated B/C Ratio:	888.1:1.

Example 4

K-TRAN Title:	Scanning Electron Microscope Studies of Silica Fume Concrete.
K-TRAN No.:	KSU-93-4.
Study Objectives:	To observe progress of hydration of Portland cement paste containing silica fume, and correlate mix specifications and concrete test results with silica fume content.
Estimated Benefits:	The researchers suggested that the construction cost savings of a bridge deck using silica fume rather than regular concrete would be approximately $15,500 in 1996. Assuming that 25 to 30 decks per year would qualify for these designs, an estimated annual savings of approximately $400,000 could be realized. The estimated potential triennial benefit would be $1,200,000. The researchers suggest a triennial savings of one-half this amount ($600,000) as a reasonable estimate of potential benefits.
Study Cost:	$36,000.
Estimated B/C Ratio:	16.7:1.

Example 5

K-TRAN Title:	Rainfall Inputs for Simulation of Design Floods for Kansas.
K-TRAN No.:	KU-93-3
Study Objectives:	Develop a "design storm" for input into a flood hydrograph model for determining hydrologic responses of Kansas streams.
Estimated Benefits:	The researcher assumed that 1) total highway construction costs = approximately $200 million per year, 2) 15 percent of the total construction cost on highway projects is drainage related, and 3) the research findings would result in a 0.1 % savings in the cost of drainage structures. Based on these assumptions, the estimated triennial benefit is $90,000.
Study Cost:	$29,500.
Estimated B/C Ratio:	3.1:1.

Example 6

K-TRAN Title:	Bridge Deck Cracking in Steel-Concrete Composite Bridges.
K-TRAN No.:	KU-94-1.
Study Objectives:	To determine the potential factors contributing to bridge deck cracking and to recommend procedures that will alleviate the problem.
Estimated Benefits:	The researcher estimated that implementation of the study findings would result in an annual savings of $1.4 million beginning fifteen years from the time the findings are implemented. This future benefit has an equivalent "present value" that should be considered. At 5% interest, $1.4 million 15 years from now is equivalent to $673,000 today. The estimated triennial (3-year) benefit is approximately $2 million.
Study Cost:	$40,000.
Estimated B/C Ratio:	50.0:1.

Example 7

K-TRAN Title:	The Economic Impact of General Aviation Airport Deterioration on Kansas Communities.
K-TRAN No.:	KSU-95-8.
Study Objectives:	To document the deterioration of Kansas general aviation airports by obtaining information regarding needed capital improvements, to measure the economic impacts of substandard airports on general aviation service users, and to identify the types of business firms whose location decisions are affected by high quality air service.
Estimated Benefits:	The researchers suggest that the study findings may attract as much as $100,000 in federal funds over a 3 year period for systems planning activities related to general aviation in Kansas.
Study Cost:	$25,000.
Estimated B/C Ratio:	4.0:1.

Example 8

K-TRAN Title:	Evaluation of Fatigue Behavior of Web (Rat Holes) for Accessibility to Transverse Butt Welds.
K-TRAN No.:	KU-95-6.
Study Objectives:	Examine the fatigue behavior of cope holes to establish the AASHTO fatigue category that governs cope holes. Develop a procedure to upgrade the fatigue behavior of existing cope holes.
Estimated Benefits:	The researcher concluded that implementation of the study findings could extend the life of bridges and result in an annual savings of $52,000 per bridge. A very conservative estimate of the triennial benefits is $156,000 ($52,000 x 3 years).
Study Cost:	$35,000.
Estimated B/C Ratio:	4.5:1.

Example 9

K-TRAN Title:	Transit Needs Assessments for Major Cities in Kansas.
K-TRAN No.:	KSU-96-7
Study Objectives:	To estimate the capital and operating costs associated with providing general public transportation services in Topeka, Wichita, Manhattan and Lawrence, Kansas over the next 10 years.
Estimated Benefits:	The results of this study were used by local transit service providers in Topeka and Wichita in preparing budgets and funding requests. The study results were provided at no cost to the local transit service providers. The results of the study also were used by KDOT in preparing the State's Long Range Transportation Plan. The KDOT portion of the research project budget was used to leverage an additional $20,000 in research funds from the Mid America Transportation Center. It is estimated that the triennial benefits of this study to local transit service providers is at least $50,000.
Study Cost:	$23,921.
Estimated B/C Ratio:	2.1:1.

Example 10

K-TRAN Title:	Pavement Performance Models: An Artificial Neural Network Approach.
K-TRAN No.:	KSU/KU-97-3.
Study Objectives:	Development of neural network-based pavement performance models for use in KDOT's Project Optimization System (POS).
Estimated Benefits:	The researchers estimate that triennial savings of $1,149,000 in fuel consumption could result from implementation of accurate POS prediction models. The estimated benefits are attributed to reduced pavement roughness.
Study Cost:	$40,000.
Estimated B/C Ratio:	28.7:1.

Example 11

K-TRAN Title:	Transit Needs Assessments for Major Cities in Kansas (Year 2).
K-TRAN No.:	KSU-97-4
Study Objectives:	To estimate the capital and operating costs associated with providing general public transportation services in Topeka, Wichita, Manhattan and Lawrence, Kansas over the next 10 years.
Estimated Benefits:	The results of this study were used by local transit service providers in Topeka and Wichita in preparing budgets and funding requests. The study results were provided at no cost to the local transit service providers. The results of the study also were used by KDOT in preparing the State's Long Range Transportation Plan. The KDOT portion of the research project budget was used to leverage an additional $15,000 in research funds from the Mid America Transportation Center. It is estimated that the triennial benefits of this study to local transit service providers is at least $30,000.
Study Cost:	$15,000.
Estimated B/C Ratio:	2.0:1.

Example 12

K-TRAN Title:	Sedimentologic and Mechanical Analysis of Uppermost Pennsylvanian and Permian Mudstones in Northeastern Kansas.
K-TRAN No.:	KSU-97-5.
Study Objectives:	To study the susceptibility of different geologic formations to slope failure and characterize the critical elements for improved prediction of slope failures.
Estimated Benefits:	The researchers suggest that if the study results prevent 1 slope failure, the resulting triennial benefits would be approximately $120,000.
Study Cost:	$39,419.
Estimated B/C Ratio:	3.0:1.

Example 13

K-TRAN Title:	Aggregate Specifications for SMA.
K-TRAN No.:	KU-97-5.
Study Objectives:	To evaluate Kansas aggregates for use in SMA mixes, evaluate moisture susceptibility, and develop related SMA aggregate specification requirements.
Estimated Benefits:	The researcher estimated that implementation of the study findings could result in a reduction of aggregate costs of $1/ton. Using average tonnage on 2 recent SMA projects, the researcher estimated potential triennial savings attributable to implementation of the research findings of approximately $44,000.
Study Cost:	$45,000.
Estimated B/C Ratio:	1:1.

Example 14

K-TRAN Title:	Use of KDOT Storm Analysis to Improve Flood Discharge Estimates.
K-TRAN No.:	KU-98-1.
Study Objectives:	To develop relationships specific to Kansas drainage basins to more confidently predict flood discharge.
Estimated Benefits:	The research results indicate that some savings may be realized by permitting use of smaller drainage structures. The researcher estimates potential triennial benefits attributable to the research of approximately $72,000.
Study Cost:	$30,000.
Estimated B/C Ratio:	2.4:1.

Chapter 4
Summary and Recommendations

4.1 Summary

Between 1991 and 2003, the K-TRAN program has funded over 200 research projects at a total program cost of $7.3 million. Since 1991, a total of 76 K-TRAN projects have been implemented (see Table 1). Estimates of monetary triennial benefits have been developed by the research project monitors for 25 of the implemented projects. The estimated benefit/cost ratio for the total K-TRAN program (i.e., including projects which have not been implemented) is 15.4. The benefit/cost ratio for projects that have been or are in the process of being implemented is 37.3. The K-TRAN Program is clearly an economically viable program.

The objectives of this research project were to: 1) identify and evaluate techniques for estimating the benefits of transportation research projects, 2) test one or more of the techniques by preparing estimates of the benefits of selected completed K-TRAN research projects, and 3) develop and document easy to use guidelines that project monitors and principal investigators can use to develop estimates of the potential benefits of research projects.

The guidelines presented in this report represent a hybrid approach to research project assessment that incorporates elements from traditional benefit-cost and multi-objective analysis techniques. The basic methodology requires the researcher to perform an initial subjective assessment of project benefits using a checklist of potential benefit categories. The researcher is then guided through a process whereby he/she is asked to attempt to quantify (i.e., assign a monetary value to) the benefits identified in the initial subjective assessment. The process provides the researcher with guidelines for developing a range of reasonable estimates of the potential economic benefits of research projects. If the process leads to the development of a monetary estimate of benefits, then a traditional benefit-cost analysis of the project can be

performed.

If it is determined that the project benefits cannot be expressed in purely economic terms, then the results of the subjective multi-objective assessment are assumed to represent the best assessment possible at that point in time. The guidelines for the multi-objective assessment technique include recommendations for rating project impacts and for identifying "successful" projects based on a project's overall rating.

Application of the recommended guidelines to develop estimates of the economic benefits of research projects is illustrated through an extensive set of examples using information from 14 completed K-TRAN projects for the period 1991-2000.

The results of this study should be useful to principal investigators, project monitors, and Area Panel members in estimating the benefits of K-TRAN projects. The establishment of a systematic procedure for assessing the benefits of proposed and implemented research projects should greatly enhance the likelihood that research personnel will view benefit assessment as an integral component of the research process. The implementation of the guidelines presented in this report should also be useful in assessing the overall economic efficiency of the K-TRAN Program.

4.2 Recommendations

Current KDOT policy requires that all K-TRAN proposals and project reports include an Implementation Plan. This study recommends that this policy be expanded to include a project "Benefit Assessment Plan". The suggested "Implementation and Benefit Assessment Plan" would require researchers and Project Monitors to follow the guidelines provided in this report and to clearly indicate the implementation potentials of each research project. In addition, the proposed Benefit Assessment Plan would clearly identify the specific benefits of project

implementation, and describe how the anticipated benefits would be quantified. Implementation of this recommendation should greatly enhance the likelihood that research personnel will view benefit assessment as an integral component of the research process. The implementation of the guidelines presented in this report should also be useful in documenting the overall economic efficiency of the K-TRAN Program in a more comprehensive manner.

Bibliography

American Association of State Highway and Transportation Officials (AASHTO): *A Manual on User Benefit Analysis of Highway and Bus Transit Improvements*, 1977.

Cambridge Systematics and Bernardin Lochmueller. *Major Corridor Investment-Benefit Analysis System,* prepared for Indiana Department of Transportation, 1996.

Lewis, D. *Primer on Transportation, Productivity and Economic Development,* National Cooperative Highway Research Program Rept. No. 342, Transportation Research Board, August 1996.

Office of Management and Budget. "Benefit-Cost Analysis of Federal Programs: Guidelines and Discounts", Office of Management and Budget, Circular No. A-94, *Federal Register,* v.57, n.218, November 1992.

Tavakoli, A., and C.S. Collyard. *Benefit-Cost Analysis of Transportation Research Projects*, prepared for Ohio Department of Transportation, 1992.

Texas Transportation Institute. *Microcomputer Evaluation of Highway User Benefits,* National Cooperative Highway Research Program, Report 7-12, Transportation Research Board, 1993.

Texas Transportation Institute. *Benefits of Research*, Research Rept. 1137-1F, 1988.

US Dept. of Commerce. "RIMS II Handbook"- *Regional Multipliers: A User Handbook for the Regional Input-Output Modeling System (RIMS II*), Second Edition, US Department of Commerce, Bureau of Economic Analysis, May 1992.

Weisbrod, G. and B. Weisbrod. "Assessing the Economic Impact of Transportation Projects: How to Match the Appropriate Technique to Your Project", presented at 76th Annual Meeting of the Transportation Research Board, Washington, DC, January 1997.

Wilbur Smith Associates. *Guide to the Economic Evaluation of Highway Projects*, prepared for the Iowa Department of Transportation, 1993.

APPENDIX A

K-TRAN Project Titles

K-TRAN PROJECT TITLES
(As of 6/18/03)

KSU-91-1 Developing a Monitoring System for the Dispensing Rate of Glass Traffic Line Beads
KSU-91-2 Economic Development and Transportation Impacts of Rail Branchline Abandonment in South Central Kansas
KSU-91-3 Prototype Expert System for Resolution of Concrete Construction Problems
KSU-91-4 An Investigation to Recommend Effective Recruitment and Related Training Options for KDOT
KSU-91-5 Studies in the Establishment of Native Woody Plants
KSU-91-6 Analysis of Shale Microfabric and Its Relationships to Mineralogy and Structural Failure

KU-91-1 Remote Sensing of Excess Moisture Content in Pavement Subgrade
KU-91-2 Bond Strength of Grouted Epoxy-Coated Reinforcement
KU-91-3 Evaluation of Automated Pavement Thickness Profiling Using Radar

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KSU-92-1 Developing a Monitoring System for the Dispensing Rate of Glass Traffic Line Beads (Prototype Development)
KSU-92-2 A Cost-Benefit Framework for Evaluating Short Line Railroad Assistance in Kansas
KSU-92-3 Monitoring Travel Patterns of Heavy Trucks
KSU-92-4 Bridge Construction Expert System
KSU-92-5 Exporting Kansas Products to Pacific Rim Countries via Rail through Port Topolobampo, Mexico
KSU-92-6 Development of a Multi-Period Multimodal Transshipment Program for Microcomputers
KSU-92-7 Developing an Inexpensive Automatic Video Recording System for Pavement Crack Analysis
KSU-92-8 An Evaluation of Policies on Highway Sign Materials

KU-92-1 Evaluation and Updating of Hydrologic Analysis Procedures Used by KDOT
KU-92-2 Computer Assisted Bridge Permit Evaluation
KU-92-3 Operational Analysis of Collector-Distributor Systems
KU-92-4 Evaluation of Location Reference System Issues
KU-92-5 Super Single Truck Tire Effects on Pavement Performance and Vehicle Regulatory Legislation

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KSU-93-1 Evaluation of Corridor Right-of-Way Preservation Programs for Kansas.
KSU-93-2 An Automated System for Determination of Pavement Profile Index and Location of Bumps for Grinding from the Profilograph Traces
KSU-93-3 The Analysis of Aggregate Shape By Means of Video Imaging Technology and Fractal Analysis
KSU-93-4 Scanning Electron Microscope Studies of Silica Fume Concrete
KSU-93-5 Development of a Prototype Accident Mapping Computer Program for Kansas
KSU-93-6 Development and Estimation of Kansas Truck Traffic Forecasting Procedures.
KSU-93-7 State Shortline Railroads and the Rural Economy (one year extension)

KU-93-1 Evaluation of In-Place Cold Mix Recycling in Kansas
KU/KSU-93-2 An Expert System for Fabrication Error Solutions
KU-93-3 Rainfall Inputs for Simulation of Design Floods for Kansas Streams
KU-93-4 Analysis of Pavement Subdrainage by Continuous Simulation
KU-93-5 Development of Hydraulic Design Charts for Type IV End Sections for Pipe Culverts
KU-93-6 Alternative PCCP Load Transfer Devices to Dowels
KU-93-7 Analysis of Incentive/Disincentive Clauses in Construction Contracts

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KSU-94-1 Transit: ADA
KSU/KU-94-2 Research to Improve Sections of the Low Volume Road Manual: Local Road Classification and Coordination with State Highway System Classification
KSU-94-3 Falling Weight Deflectometer (FWD) Study
KSU-94-4 Development of Average Accident Rates for State Highway Intersections in Kansas
KSU-94-5 Correlation of Aggregate Durability Test Methods
KSU-94-6 Use of Chunk Rubber Asphalt Concrete (CRAC) on Low Volume Roads/ Use of Recycled Crumb Rubber Modifier in Asphalt Pavements
KSU-94-7 Motorist Understanding of Traffic Control Devices

KU-94-1 Bridge Deck Cracking in Steel-Concrete Composite Bridges
KU-94-2 Development of POS Prediction Models using Project Generated Quality Assurance Data
KU/KSU-94-3 Computerized Sign Inventory Feasibility Study
KU-94-4 Development of Hydraulic Design Charts for Type I and Type III Metal and Concrete End Sections for Pipe Culverts
KU-94-5 Analysis of Bridge Backwater Conditions Using FESWMS-2DH

K-TRAN PROJECT TITLES
(As of 6/18/03)

KSU-95-1	Microcomputer Software for Financial Management by Rural and Small Urban Public Transportation Providers
KSU-95-2	Assessment of Pavement Condition of General Aviation Airports in Kansas
KSU-95-3	Employment Impact of Highway Construction and Maintenance Activities in Kansas
KSU-95-4	Improved Consolidation of Portland Cement Concrete Pavement Longitudinal Joints
KSU-95-5	Warrants for Right Turn Lanes at Unsignalized Intersections
KSU-95-6	Concrete Dead Load Deflections of Continuous Steel Girder Composite Bridges
KSU-95-7	Establishment of an FWD Calibration Facility
KSU-95-8	The Economic Impact of General Aviation Airport Deterioration on Kansas Communities
KU-95-1	Hydraulic Characteristics of KDOT Flume Inlets
KU-95-2	Development of an Interactive Program for Bridge Scour Analysis
KU-95-3	Optimal Light Sources for KDOT Roads and Facilities
KU-95-4	Cold In-Place Recycling (CIR) with Type C Fly Ash
KU-95-5	Effects of a Bypass on a Rural Kansas Community
KU-95-6	Evaluation of Fatigue Behavior of Web (Rat Holes) for Accessibility to Transverse Butt Welds
KU-95-7	Development of Project Activity Duration and Resource Requirement Algorithms
KU/KSU-95-8	Targeting Expert Systems for Bridge Engineering Mitigation
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KSU-96-1	Bridge Rating Using the KDOT-FWD and Other Methodologies
KSU-96-2	Development of Structural Layer Coefficients of Crumb Rubber-Modified Asphalt Mixes from In-situ Deflections Tests
KSU-96-3	Speed Zoning Guidelines Using Roadway Characteristics and Area Development
KSU-96-4	Use of FWD Data to Determine Pavement Structural Evaluation (PSE) Values
KSU-96-5	The Economic Impact of General Aviation Airport Deterioration on Kansas Communities (Second Year)
KSU-96-6	Use of Guardrail on Low-Volume Roads According to Safety and Cost Effectiveness
KSU-96-7	Transit Needs Assessments for Major Cities in Kansas
KSU-96-8	Feasibility of Developing a Low-Cost Crash Cushion Utilizing Waste Rubber
KSU-96-9	Long-Term Survival of Grain Dependent Short-line Railroads in the Midwest
KSU-96-10	Pilot Study to Determine Personnel Certification and Training
KSU-96-11	Minority Programs
KU-96-1	Rapid Thermal Analysis Techniques for Aggregates in Portland Cement Concrete Pavement
KU-96-2	Wetland Mitigation Effectiveness - Development of Cost-Effective Methods and Procedures for Kansas
KU-96-3	Torsion of Exterior Girders of a Steel Girder Bridge During Concrete Deck Placement
KU-96-4	Developing a Computer-Assisted Financial Assessment Model for Rural Passenger Transportation in Kansas
KU-96-5	Prototype Development of a Semiautomated Truck Permit System
KU-96-6	Effect of Segregation on Mix Properties of Hot Mixed Asphalt
KU-96-7	Utilization of Precipitation Estimates Developed from Composite Radar
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KSU-97-1	Review of the Effectiveness, Location, Design, Operations and Safety of Passing Lanes in Kansas
KSU-97-2	Feasibility Study of an Automated Motor Vehicle Accident Reporting System for the State
KSU/KU-97-3	Pavement Performance Models: An Artificial Neural Network Approach
KSU-97-4	Transit Needs Assessments of Major Cities in Kansas(Year 2)
KSU-97-5	Sedimentologic and Mechanical Analysis of Uppermost Pennsylvanian and Permian Mudstones in Northeastern Kansas
KSU-97-6	Estimation of Asphalt Pavement Life
KSU-97-7	Guidelines for Removal of Handrails on Narrow Culverts and Bridges
KSU-97-8	Wide-area Video Traffic Data Collection and Automatic Processing
KU-97-1	Predicting the Distribution of Class 1 Aggregate from Geologic and Rock Properties
KU-97-2	Performance of KDOT Temporary Erosion Control Measures
KU-97-3	Evaluation of the Comprehensive Highway Program Using Benefit-Cost Analysis
KU-97-4	Development of a Methodology for Incorporating FESWMS-2DH Results
KU-97-5	Aggregate Specifications for SMA
KU-97-6	Corrosion of Bridge Components Caused by Utility Cathodic Protection
KU-97-7	Cost Analysis and Service Station Planning for Flexible Fuel Vehicle Use in Kansas City and Wichita
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K-TRAN PROJECT TITLES
(As of 6/18/03)

KSU-98-1	Guidelines for Design of 3R Projects for Multiple Design Speeds
KSU-98-2	Pilot Instrumentation of the Superpave Test Section at the Kansas Accelerated Testing Laboratory
KSU-98-3	Assessing the Impact of Raising the Speed Limit on Kansas Highways
KSU-98-4	A Study of Asphalt Pavement Longitudinal Joints to Reduce Associated Pavement Distresses
KSU-98-5	Measurement of Aviation-Related Tax Revenue in Kansas
KSU-98-6	Analysis of Rural Intersection Accidents Caused by Stop Sign Violation and Failure to Yield Right of Way
KSU-98-7	Object Markers at Narrow Bridges
KSU-98-8	Redesign and Testing of Composite Bridge Deck Panels
KU-98-1	Use of KDOT Storm Analysis System to Improve Flood Discharge Estimates
KU-98-2	Effect of Segregation on Hot Mixed Asphalt Using the Asphalt Pavement Analyzer
KU-98-3	Hydraulic Testing of Improved Curb Inlets
KU-98-4	Performance and Constructability of Silica Fume Overlays on Bridge Decks
KU-98-5	Effects of Aggregate Angularity on VMA, Rutting and Stripping of KDOT Superpave Level 1 Mixes
KU-98-6	Evaluation of Fatigue Performance and Repair Strategies for Light Standards
KU-98-7	Statewide Mayday System Development Plan
KU-98-8	Regional/National Bridge Expert System

KSU-99-1	Identification of Hump Highway/Rail Crossings
KSU-99-2	The Role of General Aviation Airports in Medical Service Delivery to Rural Kansas Communities
KSU-99-3	Long-Range Plan to Improve Quality, Use and Understanding of the Traffic Records Data Bases Maintained by KDOT
KSU-99-4	A Study of Factors Responsible for Roughness Progression on KDOT PCC Pavements
KSU-99-5	Effectiveness of 2-Way STOP Signs at Low Volume Intersections
KSU-99-6	Update "Milestones" History Book
KSU-99-7	Refinement of Measurement Techniques of Road Profile and International Roughness Index (IRI) to Support the KDOT Pavement Management System (PMS) Annual Road-Condition Survey
KU-99-1	Hydraulic Performance of KDOT Curb and Gutter Inlets
KU-99-2	Fatigue Prone Steel Bridge Details: Investigation and Recommended Repairs
KU-99-3	Evaluation of Anti-Stripping Agents Using the Asphalt Pavement Analyzer
KU-99-4	Developing Options for an Integrated Non-Emergency Medicaid Transportation Service Delivery Network in Rural Kansas
KU-99-5	Lag Times and Times of Concentration for Urban Watersheds in Eastern Kansas
KU-99-6	Evaluation of Corrosion Protection Systems for Concrete Highway Structures
KU-99-7	Dynamic Traffic Demand Forecasting Model for Roadway Transportation Networks
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KSU-00-1	Evaluation of the Inverted-Tee Shallow Bridge System for Use in Kansas
KSU-00-2	Permeability of Superpave Asphalt Mixtures
KSU-00-3	Quick Response Community Planning
KSU-00-4	Guidelines for Center-of-Lane & Shoulder Rumble Strips on Two-Lane Rural Highways
KSU-00-5	Knowledge Management Technologies Laboratory
KSU-00-6	Performance of Major Modification Rehabilitation Strategies
KSU-00-7	Roundabout Traffic Patterns
KU-00-1	Evaluation of Rutting Potential of Superpave Mixtures Using the Asphalt Pavement Analyzer (APA)
KU-00-2	Rainfall Analysis and Maintenance of Rainfall Data Archives
KU-00-3	Torsion of Exterior Girders Improved Design Aid
KU-00-4	Evaluation of Data from Test Application of Optical Speed Bars to Highway Work Zones
KU-00-5	Evaluation of Fatigue and Repair Strategies for Light Standards: Phase 3
KU-00-6	Field Determination of Soil-Lime Content
KU-00-7	Statewide Cellular Coverage Map
KU-00-8	Evaluation of Modern Compaction Equipment and Visual QC/QA Procedures for Compaction Monitoring
KU-00-9	Analysis of Bridge Scour Using HEC-RAS 2.1
KU-00-10	Accelerated Testing for Concrete Reinforcing Bar Corrosion Protection Systems
KU-00-11	Field Instrumentation and Monitoring of KDOT Fiber Composite Bridge for Long Term Behavior Assessment
KU-00-12	The Impact of Highway Infrastructure on Kansas Production and Employment
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K-TRAN PROJECT TITLES
(As of 6/18/03)

KSU-01-1	Investigation and Quantification of Factors Affecting Aggregate Specific Gravities as determined by KDOT Test Method KT-6
KSU-01-2	Evaluating FRP Repair Method for Cracked Prestressed Concrete Bridge Members Subjected to Repeated Loadings (Phase 1)
KSU-01-3	Development of Multiple Growth Strategies for use in Developing Traffic Forecasts
KSU-01-4	Effectiveness of Automated Traffic Signal Violation Enforcement Systems
KSU-01-5	Impact of Kansas Grain Transportation on Kansas Highway Damage Costs
KSU-01-6	Update the Kansas Low-Volume Roads Handbook and the Handbook of Traffic Engineering Practices for Small Cities
KSU-01-7	Investigation of Effect of Curling on As-Constructed Smoothness and Ride Quality of KDOT PCC Pavements
KSU-01-8	Land Value Appraisal Methods for Highway Right-Of-Way Acquisition
KU-01-1	GIS-Based Dynamic Traffic Simulation System-Phase 2
KU-01-2	Steel Girder Lateral Stability
KU-01-3	Evaluation of Test Methods for Stiffness Properties of HMA
KU-01-4	Comprehensive Assessment of Needs and Practices Related to Traffic Control for Older Drivers
KU-01-5	Development Plan for Automatic Vehicle Location (AVL) in Maintenance Vehicles
KU-01-6	A Feasibility Study of Web-Based Transit Support and Technical Assistance Enhancement Program
KU-01-7	Simple Cost Effective Bridge Plans
KU-01-8	Evaluation of Performance-Based Admixture Criteria for Soil Modification and Stabilization
KU-01-9	Performance of Silica Fume Overlays on Bridge Decks

KSU-02-1	Case Studies of the Economic Impact of Highway Bypasses in Kansas
KSU-02-2	Adaptability of AASHTO Protocols for Condition Survey in Kansas NOS.
KSU-02-3	Evaluating FRP Repair Method for Cracked Prestressed Concrete Bridge Members Subjected to Repeated Loadings (Phase 2)
KSU-02-4	Roundabouts Phase II: After Study of Constructed Roundabouts at Newton, near Paola and Rice Road, I-70 Ramps in East Topeka and also US 75/46th Street
KSU-02-5	Roughness Progression on KDOT Asphalt Pavements
KSU-02-6	Resilient Modulus and the Fatigue Properties of Kansas HMA Mixes
KSU-02-7	Assessment of a Personal Rapid Transit System within a University Campus and Surrounding Community
KU-02-1	Acoustic Emission and Durability Evaluations of FRP Bridge Deck Materials
KU-02-2	Effect of Lime Application Methods on Subgrade Properties
KU-02-3	Guidelines for the Application of Temporary Rumble Strips
KU-02-4	Storm Durations and Antecedent Conditions for Flood Discharge Estimation
KU-02-5	Evaluate a web-based training program for rural transit managers and test refinements in a prototype module
KU-02-6	Effect of Flowable Fill on Abutments
KU-02-7	HEC-RAS 2.2 for Backwater and Scour Analysis-Phase II
KU-02-8	Evaluating NEXRAD Radar-Based Estimates of Intense Precipitation

K-TRAN PROJECT TITLES
(As of 6/18/03)

KSU-03-1	A Field Verification Instrument to Assess the Placement Accuracy of Dowel Bars and Tie Bars in PCCP
KSU-03-2	Development of Highway Design Verification and Passing Sight Distance Analysis via GPS Spatial Models
KSU-03-3	Life Cycle Economic Comparison of Common Sign Post Materials and Types
KSU-03-4	Mining the Kansas Traffic-Crash Database to Extract and Discover New Useful Correlations
KSU-03-5	Post-Tensioning the Inverted-Tee Bridge System for Improved Durability and Increased Span/Depth Ratio
KU-03-1	Mapping the Design Rainfall Event for Stormwater Quality Control
KU-03-2	Implementation of "first cut" evaluation of aggregate durability using clay content as indicated by spectral gamma ray logging of limestone aggregate
KU/KSU-03-3	A Study of the Duties of a County Engineer in the State of Kansas
KU-03-4	Development of Analysis Methodology for Combined Flow at Bridges
KU-03-5	Treatment of Contaminated Roadway Runoff Using Vegetated Buffer Zones
KU-03-6	Assessment of the Cost-Effectiveness of Deer-Vehicle Collision Countermeasures
KU-03-7	Analysis of Statewide Wireless Communications
KU-03-8	Use of Fiber Composite Materials for Fatigue Crack Repair in Steel Bridge Girders and Other Metal Structures (Exploratory Project)
KU-03-9	Evaluation of Limestone Resources in Douglas, Franklin and Miami Counties

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KSU-04-1	Development of a Materials and Engineering Database for "Shales" of Eastern Kansas
KSU-04-2	Examining New Strengthening Alternatives for Bridge Beams to Identify the Most Viable Practice
KSU-04-3	The Impact of Jumbo Covered Hopper Cars on Kansas Shortline Railroads
KSU-04-4	Implementation of the 2002 AASHTO Design Guide for Pavement Structures in KDOT
KSU-04-5	Road Weather Forecast Quality Analysis
KSU-04-6	Development of Stiffness-Based Specifications for In-Situ Embankment Compaction Quality Control
KU-04-1	Bridge Analysis Using the HEC-RAS Unsteady Flow Module
KU-04-2	Development of a System for the Retrieval and Analysis of Historical Subgrade Information
KU-04-3	Storage Considerations in Culvert Sizing
KU-04-4	Assessment of the Cost-Effectiveness of Deer-Vehicle Collision Countermeasures, Phase II
KU-04-5	Continuous Field Monitoring of Existing Steel Bridges and Critical Connections for KDOT
KU/KSU-04-6	The Development of Possible Plans to Provide Engineering Services at the County Level
KU-04-7	Developing a Web-based Training Center
KU-04-8	Economic Feasibility of Using KDOT Fiber Optic Infrastructure for the Transmission of KDOT Data
KU-04-9	Downstream Effects of Enlarged Waterway Openings

APPENDIX B

Research Project Assessment Forms

KDOT RESEARCH PROJECT IMPLEMENTATION PLAN

DESCRIPTION OF PROJECT:

RESEARCH STUDY NO.: KDOT PROJECT NO.:

TITLE:

PRINCIPAL INVESTIGATORS:

PROJECT MONITOR:

AREA PANEL LEADER:

CONTRACTING AGENCY:

STUDY COST:

A. SUMMARY OF RESEARCH FINDINGS -Enough detail should be given to provide a basic understanding of the project without necessitating reading the final report

_____
_____
_____
_____
_____
_____

B. IMPLEMENTATION POTENTIAL - Explain how the research study solved the problem, specify the types of changes being recommended, and describe the expected benefits of implementation (see Part F of this Form). Determine if implementation is warranted or further research or development is needed

_____
_____
_____
_____
_____
_____
_____

C. IMPLEMENTATION STRATEGIES -The goals and scope of implementation, any potential problems or constraints, and the tools needed to achieve implementation. Include any approvals required.

D. TASK SCHEDULING -Describe tasks and assign responsibilities to functional areas and a time schedule for completion of activities.

E. BUDGET ESTIMATING -Detail the expected costs of implementation as well as the anticipated benefit saving from implementation (See Part F of this Form).

F. PROJECT ASSESSMENT USING MULTI-OBJECTIVE CRITERIA. In the following Table, rate the project on the basis of the extent to which the project, if implemented, would result in a benefit in each of the assessment categories. Rate from 1 to 10, with 10 being the most successful. Rating Guide: N/A = factor does not apply to this project; 0 = absolutely no benefit; 1 = intuitive feeling that the project has some slight benefit; 5 = no clear evidence but strong subjective feeling that the project has a significant benefit; 10 = clear evidence or strong feeling the project has an excellent to outstanding positive benefit. [Note: A rating of "5" in at least one of the Assessment Categories indicates a "successful" (cost effective) project. This criterion should be considered when assigning numeric ratings.]

Assessment Category	Subjective Rating	Triennial Benefits ($)	Comments
Construction Savings (materials, labor, equipment, time, quality)			
Operation and Maintenance Savings (materials, labor, equipment, time)			
Increase Lifecycle			
Decrease Lifecycle Costs			
Safety (Reduction of crash frequency. Reduction of crash severity)			
Decrease Engr./Admin. Costs (planning/design costs, paperwork)			
Environmental Aspects (pollution, hazardous waste reduction, recycling)			
Technology (technology transfer, new materials, new methods)			
User benefits (time, dollars)			
Impact On KDOT Policy			

Prepared by: _____ _____
K-TRAN Project Monitor Date

Approved by: _____
K-TRAN Area Panel Leader

State of Kansas - Department of Transportation

RESEARCH PROJECT IMPLEMENTATION PROGRESS REPORT

Title of Study				Study Number
Study Objective			KDOT Project No.	Principal Investigator
				Impl. Manager
Project Budget	Implement Budget	Total Budget	Projected Triennial Benefits	Projected B/C Ratio
Project Exp.	Implementation Exp.	Total Expenditures	Actual Triennial Benefits	Actual B/C Ratio

Research Findings

		2004		2005				2006		
List of Implementation Tasks List specific major tasks or phases to accomplish the findings Use an "S" to indicate the Starting Date and a "C" to indicate the Completion Date	Prior	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Jul - Sep	Oct - Dec	Jan - Mar	Apr - Jun	Beyond

Explain what was done this period.
Describe any unanticipated problems that arose this period or any recent implementation.

Briefly describe the work planned for the next period along with any projected deviations from the work plan or anticipated modifications to the cost estimate or the work schedule.

Project Monitor's Signature	Progress Reporting Date

APPENDIX C

Suggested Benefit Values for Selected Impact Categories

TABLE C-1: Valuation of Vehicle Operating Costs

Vehicle Type	Vehicle Operating Cost per 1000 Miles of Travel		
	Cost ($) at 20 mph	Cost ($) at 55 mph	Cost ($) at 65 mph
Car	220	275	275
Single Unit Truck	600	650	710
Tractor Trailer Truck	600	820	875

Source: AASHTO (1977). Adjusted to 2003 at 3% annual inflation.

TABLE C-2: Valuation of Travel Time

Category of Travel	Typical Hourly Values ($)	
	Per Vehicle	Per Person
Freight (Tractor Trailer)	25	25
Freight (Single Unit Truck)	20	20
Persons (Work Trips)	15	15
Persons (Non-Work Trips)	5	10

Source: Weisbrod and Weisbrod (1997). Updated to 2003 at 3% annual inflation.

TABLE C-3: Recommended Values for Traffic Crashes

Crash Category	Cost ($)
Fatality	3,952,000
Injury	342,000
Property Damage Only	2,500

Source: KDOT Bureau of Transportation Planning. Updated from 1996 to 2003 at 3% annual inflation.