Submitted to:

Minnesota Department of Transportation

October 1990

Final Report

Results of the Minnesota Highway User Cost Allocation Study

Submitted by:

Cambridge Systematics, Inc.
Sydec, Inc.
The Urban Institute
Jack Faucett Associates

Consultant's Report prepared for the Department of Transportation

Pursuant to 1989 Laws, Chapter 250, section 6

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Summary of Findings and Recommendations

■ Scope of Study

This report presents the results of the Minnesota Highway User Cost Allocation Study. A cost allocation study provides information on the fairness of highway user taxes and fees with respect to different vehicle classes such as automobiles, buses, and various types of trucks. The degree of fairness, or equity, is determined by comparing the highway-related charges paid by each vehicle class to its fair share of highway-related expenditures (referred to as that class's "cost responsibility"). Based upon these findings, changes in the road financing structure could be proposed if needed to increase equity by bringing user payments more closely in line with cost responsibilities for each vehicle class.

The scope of the Minnesota study is a comprehensive one, including both State-administered roads and local roads, and considering user payments and shares of cost responsibilities incident to Federal programs as well. A cost allocation study is limited, however, only to considerations of the equity of highway-related taxes and fees. Furthermore, its allocations of cost responsibilities for highway expenditures are based solely upon current or projected highway programs. Therefore, a cost allocation study does not include any estimate or evaluation of highway needs, nor does it consider whether new sources of revenue might be required to fund unmet needs now or in the future.

The determination of equity requires a comparison of total highway-related payments (or revenues) vs. total highway-related cost responsibilities for each vehicle class. As used in this study, the terms "highway-related payments" or "revenues" will refer to all taxes, fees, or other imposts that are unique to highway users. Furthermore, it is the total payments or revenues that are considered, whether or not the entire amount is in fact directed to highway purposes. Similarly, "cost responsibilities" are based upon respective shares of total highway-related expenditures, whether from highway funds or from the General Fund.

With these stipulations, we present in the following sections a summary of the key findings and recommendations of this study.

■ Key Findings

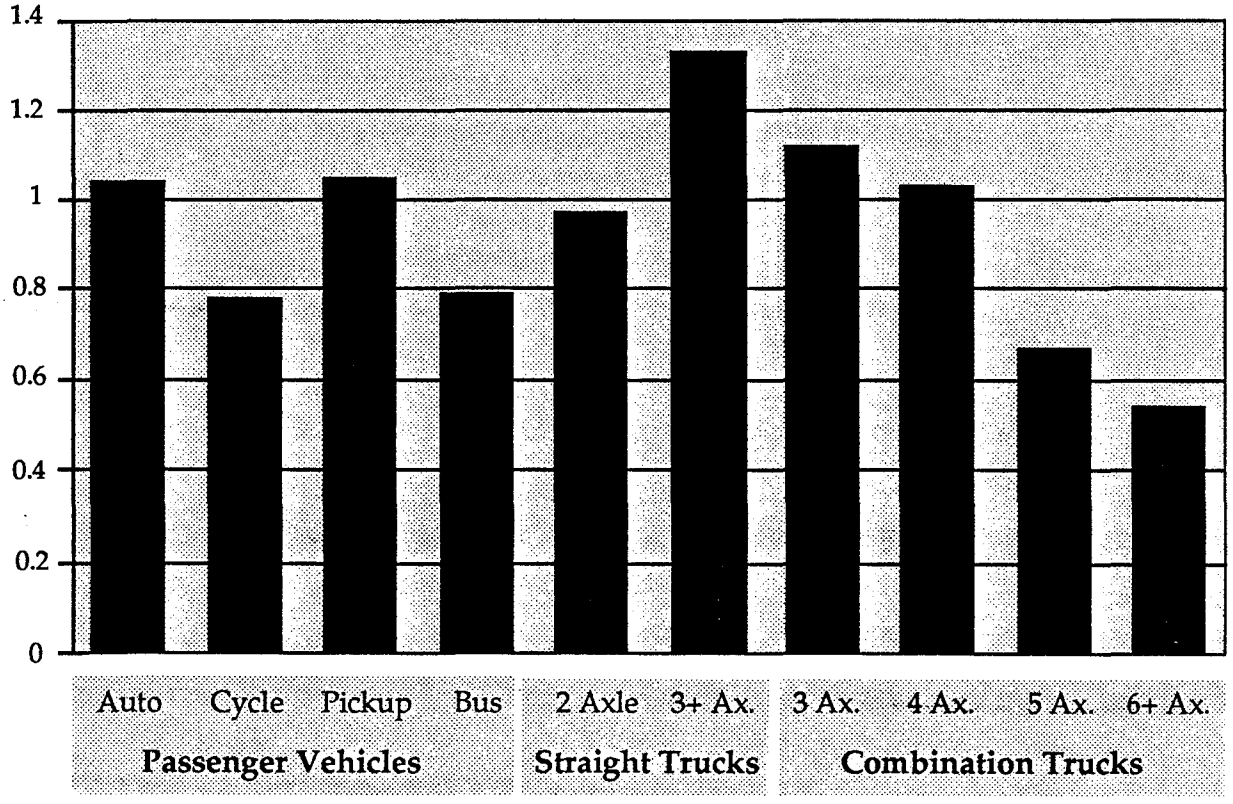
1. Minnesota's highway user taxes and fees currently exceed total highway-related expenditures by about $5 million per year when both revenues paid into, and expenditures from the General Fund are included.

2. Single unit three or more axle trucks are significantly overpaying from an equity point of view, while motorcycles and five or more axle combination trucks are underpaying. (See Exhibit 1.) Automobiles, pickups and vans, two axle single unit trucks, and three and four axle combinations are paying their fair share or somewhat more. Buses as a whole are underpaying, but when transit and school buses are removed from the analysis, those remaining buses that pay standard taxes and fees are approximately paying their share.

3. Over the next few years, if there is no change to the current fee structure, highway revenues will not keep pace with inflation -- i.e., revenues will decrease in constant dollar terms. As currently structured, the motor vehicle excise tax on trucks and registration fees for passenger vehicles (which are based on value) are the only highway user revenue sources likely to keep pace with inflation. Registration fees are a fixed rate tax and receipts from gasoline and diesel taxes may even decrease in current dollar terms as vehicles become more fuel efficient.

Exhibit 1. Equity of Minnesota's Highway User Taxes FY 1991-95

Ratio of Taxes Paid to Fair Share of Costs



■ Key Recommendations

1. Adjustment should be made in Minnesota's tax structure to make the system more equitable. Specifically, taxes and/or fees should be increased for the larger combination trucks and for motorcycles. We urge consideration of the following alternatives:

   (a) Increase the diesel tax rate. This would be one of the easiest options to implement because it would not introduce any added administrative or enforcement problems or costs, or any added compliance burden on industry, such as reporting or record keeping requirements. However, a flat rate increase for the diesel tax would increase the tax burden on some truck classes that are already overpaying.

   (b) Create a diesel surcharge to be paid only by heavier trucks on a quarterly or other periodic reporting basis. This would be relatively easy to enforce and administer for all trucks now subject to fuel use tax reporting, but has the disadvantage that this reporting requirement and taxation system would have to be extended to many intrastate vehicle operators that do not presently have to file periodic fuel use reports and pay fuel use taxes.

   (c) Increase registration fees for heavier trucks. This would add nothing to current enforcement, administration, and compliance costs, and would apply to all out-of-state-based vehicles that currently pay prorated registration fees. However, it has the disadvantage of being unrelated to miles of travel for intrastate vehicle operators and only partly related to miles of travel in Minnesota by interstate vehicles.

   (d) Increase excise taxes on heavier trucks. This has the same advantage of ease of enforcement and administration as (b), but would not apply to out-of-state-based vehicles at all and is unrelated to miles traveled.

   (e) Place a property value tax on trucks, including out-of-state vehicles that travel in Minnesota. This would decrease the inequities for heavy trucks as a whole but would be unrelated to operating weight and miles traveled.

   (f) Establish a weight-distance tax that would apply to all heavy trucks that travel in Minnesota. This would be the most equitable option if properly administered and enforced. However, this is one of the

most difficult tax structures in terms of administration, enforcement, and burden on motor carriers, and is the most controversial tax option.

(g) Increase registration fees and/or excise tax rates for motorcycles.

(h) Reduce registration fees and/or excise tax rates for lighter single unit three or more axle trucks.

2. In order to make transportation revenues keep pace with inflation, Minnesota's fuel tax rates and registration fees could be indexed in some way. This might involve tying these taxes to a highway cost index such as the Federal Highway Administration's index of construction cost trends or a new index that Minnesota might develop from available State data. Alternatively, truck registration fees could be linked to vehicles' value, or fuel taxes could be a percent of fuel price.

3. Change revenue structures to allow residents who itemize to deduct some fees from Federal taxes. Flat registration fees are not deductible, but personal property taxes on vehicles are. This would allow more dollars to remain in the State.

4. Adopt a policy of conducting periodic highway cost allocation studies to assure continuing monitoring of the equity of Minnesota's tax structure.

1.0 Introduction

1.1 Objectives and Scope of the Study

This report presents the results of the Minnesota Highway User Cost Allocation Study. The objectives of this study were threefold:

- To conduct a comprehensive study of highway user charges vs. cost responsibilities in Minnesota by user class, considering both state-administered roads and local roads, and including also the user payments and shares of cost responsibilities incident to federal programs;
- To determine the equity of the current road financing structure in Minnesota, and to recommend changes if needed to bring highway user payments more closely in line with cost responsibilities for each user class; and
- To document the findings of this study in a final report, and to implement the resulting cost allocation methodology in a computer system that enables Minnesota to undertake future updates of this cost allocation procedure.

Highway cost allocation studies provide information on how fair current or proposed fees or taxes are with regard to each vehicle class such as automobiles, buses, or five-axle combination trucks. In this study, we have identified the various classes of vehicles that have different responsibilities for

Minnesota highway costs and made estimates of the revenue being contributed toward highway expenditures by each class of vehicle. By comparing the cost responsibility of each class of vehicle and the revenues that each is contributing to fund highway expenditures, the Legislature can make informed judgments about whether changes in the fees and taxes which support highways would be fair and desirable.

Cost allocation analysis involves building a series of models that describe the cost components of various parts of the highway system. One model, for example, looks at the various cost components of highway maintenance, the components being such expenditures as pavement surface treatment, snow plowing, and salting. The model then allocates costs for each component to various vehicle classes. Since snow plowing is required by all vehicles we divide the cost of this component equally among all vehicle classes in proportion to the number of miles traveled by each.

Other models are far more complex because different classes of vehicles have different design requirements. If only automobiles were to use a specific road, for example, the road could be built with thinner pavements, as well as fairly steep grades, lighter bridges, and perhaps narrower lanes. If heavier trucks were expected, thicker pavements would be required, along with flatter grades, stronger bridges, and perhaps wider lanes. A pavement cost model breaks out cost components and assigns them to the vehicles that necessitate them, so that heavier trucks would be assigned the cost of making the pavement thicker with a deeper base. Other allocation procedures deal with pavement rehabilitation, new bridges, bridge replacement and rehabilitation, highway patrol, and administration of transportation programs.

In the fall of 1989, the Minnesota Department of Transportation hired the team of Cambridge Systematics, Inc., Sydec, Inc., The Urban Institute, and Jack Faucett Associates to perform such a cost allocation study for the State of Minnesota. The results are summarized in this report. The report describes our findings on the equity of Minnesota's current tax structure, and discusses possible changes that would improve equity among the various classes of highway users.

We are also providing to MnDOT a set of Lotus 1-2-3 computer spreadsheets for performing various analyses of Minnesota's highway user tax structure and highway programs. The importance of the last product should be stressed. Minnesota has not performed a highway cost allocation study in the past. Although this study provides a comprehensive assessment of the current equity of the tax structure, many factors may occur in the near future which could change the findings, such as redirection of the highway program, changes in prices for vehicles, fuel, or components of highways, and adjustments to highway user taxes and fees.

We will be available for a reasonable period after submission of a more detailed final report to advise and/or assist staff analysts in implementing the spreadsheets.

■ 1.2 Organization of the Report

The remaining two chapters present (1) forecasts of all factors required for the cost allocation study and (2) the results of the cost allocation for all expenditures of State funds for highway-related programs, including State Aid and transit assistance to local governments and transit agencies. Adjustments due to the inclusion of local roads and Federal assistance for highways are also presented. The forecasts include vehicle miles of travel (VMT) on each class of highway, vehicle population and VMT for each major class of vehicle, highway user revenues of each type, revenues by vehicle class, and expenditures by major program category and construction activity.

The relevant time periods of the forecasts and cost allocation in Chapters 2.0 and 3.0 are the study base year (FY 1989) and the five year capital improvement program period Fiscal Years 1991-1995.

2.0 Forecasts for the Cost Allocation

This chapter provides a summary of the forecasts necessary for the cost allocation assessment in Chapter 3.0. For many of the forecasts summarized here, we have had to prepare more detailed forecasts summarize here, we have had to prepare more detailed forecasts which will be documented and made available to the Department of Transportation in a report appendix. The forecasts presented here are divided into four categories: travel, revenues, expenditures, and the attribution of revenues to vehicle classes.

■ 2.1 Travel

Exhibit 2 provides estimates of travel on Minnesota highways by vehicle class in Fiscal Year 1989 and a short range forecast of travel in Fiscal Year 1993. Fiscal Year 1993 has been used for the forecast because it is the mid-year of the latest capital improvement program period, FY 1991-95. All these VMT forecasts can readily be converted into forecasts for the cost allocation by multiplying by five.

The forecast growth in statewide VMT totals 9.4 percent for the four year period from FY 1989 to FY 1993 -- equivalent to an annual growth rate of 2.3 percent. Truck VMT is projected to grow at an annual rate of 3.0 percent;

Exhibit 2. Travel on Minnesota Streets and Highways by Vehicle Class

	Millions of VMT Per Year	
	FY 1989	**FY 1993**
Automobiles	24,990	27,317
Motorcycles	314	343
Pickups and Vans	8,792	9,611
Buses	191	209
Single Unit Trucks		
2 Axle	763	859
3+ Axle	293	330
Combinations		
3 Axle	80	90
4 Axle	271	305
5 Axle	1,154	1,299
6+ Axle	93	104
All Vehicles	**36,940**	**40,466**

Source: Study team analysis of Minnesota registration and traffic data. Traffic growth from FY 1989 to FY 1993 is projected based on growth rates from the FHWA-Faucett VMT Model and trends in growth in VMT on Minnesota highways.

while VMT by autos and other personal use vehicles is projected to grow at an annual rate of 2.2 percent.

Exhibit 3 provides a tabulation of the existing mileage of Minnesota's streets and highways by highway functional class and Minnesota administrative system. Although the functional class system used in this exhibit and used throughout the cost allocation study is not very familiar to many people (except for the Interstate system), it provides a logical hierarchical structure and a very useful basis for many analyses. Many sets of data are available with breakdowns by functional class, and all streets and highways nationwide have been structured into these categories using a uniform set of criteria developed by the Federal Highway Administration and implemented by the Minnesota Department of Transportation. Urban areas include communities of 5,000 or more population and all built-up areas outside of such municipalities. Within rural and urban areas, all routes are categorized under this system so that routes serving important destinations, heavier volumes of traffic, and longer distance trips are in the higher categories. As one moves down the list, each functional class forms a logical addition to the highway network, while progressively adding routes serving less important destinations, lower traffic volumes, and shorter average trip lengths.

Exhibits 3 also provides a breakdown of mileage by Minnesota administrative system. The State Trunk Highway System serves interstate travel and provides the primary linkages between communities in Minnesota. Highways on this system are the responsibility of the State. State aid highways include the County State Aid Highway System and the Municipal State Aid Street System. The establishment of these highway systems was authorized by the Legislature in 1957. These highways are the responsibility of cities and counties; however, projects on these highways are eligible to receive State support from the County State Aid Highway and Municipal State Aid Street Funds. Note that nearly all of the mileage of the three highest rural classes and the three highest urban classes are the responsibility of the State. Responsibility shifts to nearly complete local control for the lowest functional classes.

Exhibit 4 provides a tabulation of travel on Minnesota's streets and highways by highway functional class and Minnesota administrative system. Vehicle miles of travel per mile of highway decrease with each step down the functional class list within both rural and urban areas (although VMT per mile is higher, of course, in urban areas for similar functional classes).

The majority of the State's VMT (58 percent) is on the State Trunk Highway System, even though that system makes up only nine percent of statewide mileage of streets and highways. The highest traffic volumes are on the Interstate system, which carries 19 percent of VMT on only 0.7 percent of total mileage.

Exhibit 3. Miles of Streets and Highways in Minnesota

Functional Class of Highway	Trunk Highways	State Aid Highways	Other Roads	Total
Rural				
Interstate	687	0	0	687
Other Principal Arterial	3,354	2	1	3,357
Minor Arterial	5,326	2	7	5,335
Major Collector	1,526	14,600	575	16,701
Minor Collector	5	9,820	1,991	11,816
Local	6	4,358	73,075	77,439
Urban				
Interstate	227	0	0	227
Other Freeway & Expressway	131	0	0	131
Other Principal Arterial	536	51	1	588
Minor Arterial	270	1,156	114	1,540
Collector	25	1,426	417	1,868
Local	9	910	9,016	9,935
Totals	**12,103**	**32,325**	**85,197**	**129,624**

Source: Minnesota Department of Transportation.

Exhibit 4. Projected Travel on Minnesota Streets and Highways

Functional Class of Highway	FY 1993 Vehicle Miles of Travel (millions) Trunk Highways	State Aid Highways	Other Roads	Total
Rural				
Interstate	2,893	0	0	2,893
Other Principal Arterial	4,937	3	1	4,940
Minor Arterial	3,524	1	4	3,529
Major Collector	371	3,505	121	3,997
Minor Collector	20	966	173	1,159
Local	286	150	2,243	2,678
Urban				
Interstate	4,936	0	0	4,936
Other Freeway & Expressway	2,139	0	0	2,139
Other Principal Arterial	2,856	255	6	3,117
Minor Arterial	1,114	4,064	287	5,464
Collector	95	2,137	507	2,740
Local	299	242	2,330	2,871
Totals	**23,470**	**11,323**	**5,673**	**40,466**

Source: Minnesota Department of Transportation estimates of traffic by highway functional class were projected to FY 1993 based on growth rates from the FHWA/Faucett VMT Model and trends in growth in VMT on Minnesota highways.

2.2 Revenues

Exhibit 5 shows all State highway user revenues in Fiscal Year 1989 and a projection of these revenues to Fiscal Year 1993, under current tax laws. Within the context of this study, "revenues" refer to total highway related payments by users, regardless of whether or not these payments are dedicated to highway purposes. The overall growth rate projected for revenues is about 3.1 percent per year in **current dollar terms**, which is below the inflation rate of four percent that has been assumed in these forecasts. This implies a decrease of revenues in **constant dollar terms** of about one percent per year.

Exhibit 6 graphically portrays this projected decrease in highway investment by plotting expected revenues in **constant FY 1989** dollars over the next 11 years. The overall projected decrease in real terms will be about 11 percent if no changes in tax structure occur.

This overall revenue trend is a composite of different trends for each revenue source that are crucially important to understand in considering possible changes in tax rates.

In current dollar terms, fuel taxes are projected to grow at less than one percent per year. Without any changes in tax rates, these sources increase only in proportion to vehicle use, and are not influenced directly by inflation. Changes in fuel economy of vehicles will influence fuel tax receipts, but these are projected to be very slight relative to most other changes affecting tax receipts. Fuel tax receipts may actually decrease if fuel price increases significantly and if fuel economy improves more than recent trends.

Registration fees and excise taxes (i.e., total MVET payments, including both the portion dedicated to highways and the portion going into the General Fund) are expected to grow at about four percent per year in current dollars, just offsetting inflation. These tax receipts increase with growth in vehicle ownership and the purchase price of vehicles.

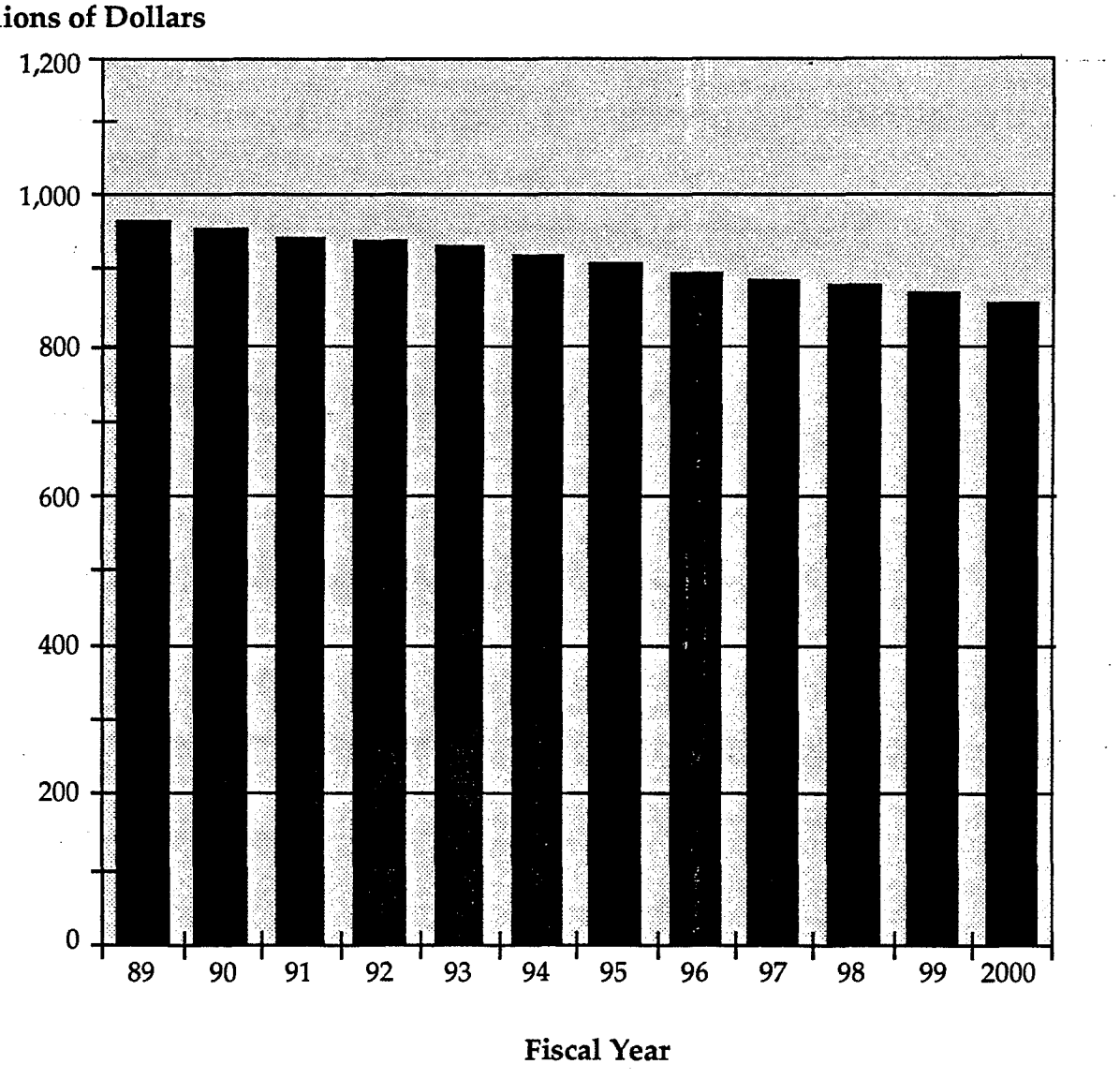
This tabulation of revenues focuses on those taxes or fees that are unique to highway users. It is recognized that both individuals and industries pay other types of taxes, a portion of which may potentially be directed to transportation purposes. However, since these latter charges are levied upon some basis other than highway use, they are not included in a highway cost allocation study.

Exhibit 5. Projected Highway User Revenues

	Revenues (millions)	
	FY 1989	**FY 1993**
Fuel Taxes	$437.3	$444.1
Registration Fees	265.7	352.9
Motor Vehicle Excise Tax (MVET)	249.9	273.1
Drivers' License Fees	15.0	20.4
TOTAL	**$967.9**	**$1090.5**

Source: Minnesota Department of Transportation projections.

Exhibit 6. Projected Highway User Revenues in Constant FY 1989 Dollars



2.3 Expenditures

Exhibit 7 provides a summary tabulation of FY 1989 expenditures by all levels of government for highways from all sources. For purposes of the cost allocation, expenditures have been summarized in this exhibit in a somewhat different form from other available tabulations. Expenditures have been sorted out by source in terms of level of government so that attention can be focused on State tax policy, while continuing to analyze State highway programs in the context of all highway expenditures in the State. Capital improvements for highways have been added together, regardless of source (General Fund, Trunk Highway Fund, State Aid funds, etc.) because capital expenditures are allocated to vehicle classes using unique methods described in the next chapter. Similarly, all commercial vehicle-related programs have been added together because they relate to particular classes of vehicles. Transit programs are separated out because they relate only to travel in urban areas. Finally, those transportation expenditures that do not directly relate to current highway services or improvements (e.g., other modes of transportation) have been separated out in the exhibit.

Exhibit 8 provides forecasts of all transportation expenditures in Minnesota for the latest five year capital improvement program period, Fiscal Years 1991-1995, in the same format as Exhibit 7. The officially adopted five year improvement program provides a major basis for the forecasts. Other elements of the forecasts are based on actual appropriations for FY 1990-91, various staff projections, and advice from the Minnesota Department of Transportation (MnDOT) and the Department of Public Safety. The average annual increase is 4.5 percent for State programs (included State assistance programs), and is 1.3 percent and 4.0 percent for Federal and local programs respectively.

The forecasts shown in Exhibit 8 are compatible with the revenue forecasts for FY 1993 shown in Exhibit 5, although differences exist due to such items as changes in fund balances, income from investment of reserves, and funding from sources other than highway users.

When total State highway user revenues in Exhibit 5 are compared with total expenditures of State funds (including State assistance programs) in Exhibits 7 and 8, the revenues are seen to be somewhat less than expenditures ($968 million vs. $1006 million in FY 1989, and $1091 million in revenues in FY 1993 vs. $5581 million in expenditures for FY 1991-95, or $1116 million per year). When only highway-related programs (including transit assistance) administered by State government are considered, State highway user revenues fully cover program expenditures for both FY 1989 and FY 1991-95 ($968 million vs. $963 million in FY 1989, and $1091 million vs. $5407 million for FY 1991-95, or $1081 million per year), subtracting $43 million and $174

Exhibit 7. Minnesota Expenditures from All Sources for Transportation in FY 1989 (millions)

Type of Expenditure	State Programs	State Assistance	Federal Aid	Local Programs
Capital Improvements				
Trunk Highways	$283	$ 0	$219	$ 0
State Aid Highways	0	248	47	17
Local Streets & Highways	0	0	20	414
Maintenance				
Trunk Highways	123	0	0	0
Local (incl. State Aid Highways)	0	97	0	215
Commercial Vehicle Programs	6	0	1	0
Transit Assistance	0	41	22	55
Other Programs				
Department of Transportation	84	0	4	0
Other Depts. & Tax Collection Costs	81	0	1	0
Local (other than capital & maint.)	0	0	0	189
Total Highway-Related	$577	$386	$313	$890
Other (other modes, debt service & repayments)	43	0	22	147
Totals	**$620**	**$386**	**$336**	**$1,037**

Source: (1) Minnesota Department of Transportation spreadsheet: Trunk Highway Fund Revenue and Expenditures Projection: FY 1986-FY 1995.

(2) 1990-91 Biennial Budget Program Structure for MnDOT.

(3) Various staff of MnDOT and MnDPS.

Exhibit 8. Minnesota Expenditures from All Sources for Transportation in FY 1991-95 (millions)

Type of Expenditure	State Programs	State Assistance	Federal Aid	Local Programs
Capital Improvements				
Trunk Highways	$1,464	$ 0	$1,095	$ 0
State Aid Highways	0	1,311	253	95
Local Streets & Highways	0	0	116	2,470
Maintenance				
Trunk Highways	657	0	0	0
Local (incl. State Aid Highways)	0	516	0	1,250
Commercial Vehicle Programs	39	0	8	0
Transit Assistance	0	218	111	324
Other Programs				
Department of Transportation	707	0	22	0
Other Depts. & Tax Collection Costs	495	0	3	0
Local (other than capital & maint.)	0	0	0	1,071
Total Highway-Related	$3,362	$2,045	$1,608	$5,210
Other (other modes, debt service & repayments)	174	0	163	862
Totals	**$3,536**	**$2,045**	**$1,771**	**$6,072**

Source: (1) Minnesota Department of Transportation spreadsheet: Trunk Highway Fund Revenue and Expenditures Projection: FY 1986-FY 1995.

(2) 1990-91 Biennial Budget Program Structure for MnDOT.

(3) Various staff of MnDOT and MnDPS.

million for the two periods in "other" expenditures (other modes of transportation, debt service, and repayments to local governments).

Exhibit 9 shows how the projected capital improvement program expenditures have been converted into estimates of the amounts of expenditures for specific construction activities that can be allocated to vehicle classes. The row headings in the exhibit are program categories that are used by MnDOT in preparing each annual update of the five year program. As can be seen in the table, none of these program categories are "pure" categories in terms of the specific type of construction involved. The columns of the table define the categories of construction activity needed for the cost allocation to vehicle classes.[1]

Exhibit 10 shows the estimated distribution of total (State plus Federal) and State capital expenditures by functional class of highway for FY 1989.[2] The second column takes into account the much higher proportion of Federal funds for Interstate construction than for functional classes. Ideally, estimates of this distribution should be available separately for each major program category because of the large difference in traffic mix on the functional classes and the substantial difference in the proportions of cost responsibility for different types of construction activity. Such data are not available, so the assumption has been made that all categories of construction activity have the same percentage distribution among functional classes. The results of the cost allocation process are not very sensitive to moderate changes in this distribution, so that this is not judged to be a significant shortcoming of the study.

Note that the percentage in the first column of Exhibit 10 for Interstate in urban areas is very high. This is expected to hold approximately for FY 1989 because of continuing major projects in the Metro area. Note, on the other hand, that the percentage for rural Interstate highways is slightly lower than for the next two lower rural functional classes. This is a major reversal of the pattern of the last thirty years, during which construction was concentrated on the Interstate system. A shift of this type can be expected to occur in urban areas in the future as well. These changes have implications for cost allocation because of the heavy concentration of larger combination trucks on the Interstate system. As construction is completed on the Interstate system and priority shifts to other functional classes, the share of cost responsibility will shift to other vehicle classes.

1/ The percentage distribution of expenditures across program categories in Exhibit 9 was developed by the consultant team from a sample of construction projects in each program category for FY 1989 using detailed cost estimates for each project.

2/ This distribution is based on data for the FY 1987 and 1988 programs, since data on this distribution were not yet available for FY 1989.

Exhibit 9. Conversion of Capital Improvement Program into Categories of Construction Activity

	Proportion of Program Expenditures in Each Category of Construction Activity									FY 1989 Program State Funds (millions)
	New Pavement	Pavement Rehabil.	New Bridges	Bridge Replace	Bridge Repair	Grading & Drain	Prelim. & Const.Eng.	Misc.	Total	
Bridge Improvement	0.12	0.05	0.00	0.41	0.15	0.01	0.10	0.17	1.00	$ 6.25
Bridge Replacement	0.21	0.26	0.00	0.15	0.00	0.17	0.09	0.11	1.00	36.37
Interstate Completion	0.16	0.00	0.17	0.00	0.00	0.18	0.09	0.40	1.00	16.95
Interstate Preservation	0.18	0.16	0.05	0.21	0.02	0.06	0.10	0.22	1.00	15.50
Interstate Substitution	0.32	0.00	0.03	0.00	0.00	0.10	0.09	0.47	1.00	0.02
Major Constr. & F.A. Urban	0.32	0.00	0.03	0.00	0.00	0.10	0.09	0.47	1.00	40.13
Reconstruction	0.51	0.01	0.00	0.01	0.00	0.27	0.09	0.10	1.00	61.83
Reconditioning	0.09	0.53	0.00	0.00	0.00	0.14	0.09	0.14	1.00	31.52
Resurfacing	0.06	0.75	0.00	0.00	0.00	0.03	0.09	0.07	1.00	43.23
Safety Improvement	0.34	0.12	0.00	0.00	0.04	0.13	0.09	0.29	1.00	13.43
Right-of-Way & Agreements								1.00	1.00	17.27
Totals										**$282.50**
Program Amounts (millions)	$68.26	$64.05	$4.78	$12.12	$1.74	$38.46	$24.21	$68.88	$282.50	

Exhibit 10. Distribution of State Capital Expenditures by Functional Class for FY 1987-88 and 1989

Functional Class of Highway	Percent Distribution from 1987-88 Program State & Federal	Percent Distribution State Funds FY 1989	FY 1989 State Expenditures (millions)
Rural:			
Interstate	9.3%	3.8%	$10.8
Principal Arterial	12.4	22.0	62.1
Minor Arterial	10.5	18.6	52.6
Major Collector	1.3	2.3	6.4
Minor Collector	0.1	0.2	0.4
Subtotal	33.6	46.8	132.2
Urban:			
Interstate	47.3	19.4	54.8
Freeway and Expressway	4.7	8.4	23.7
Other Principal Art.	9.0	16.0	45.1
Minor Arterial	5.3	9.4	26.5
Collector	0.1	0.1	0.3
Subtotal	66.4	53.2	150.3
Total	**100.0%**	**100.0%**	**$282.5**

Source: Form FHWA 534 prepared by Minnesota DOT.

Exhibit 11 shows the distribution of capital expenditures that was used in the cost allocation for the program period. It is based on a judgement that the split in expenditures between rural and urban areas will remain the same (a ratio of about 1:2). However, the program for FY 1991-95 will have construction shifting toward more emphasis on non-Interstate highways in both rural and urban areas. This implies a continuation of the current pattern of about 20 times as much expenditure per lane mile in urban areas.

Maintenance expenditures by functional class are assumed to remain in the same proportions as they were in the base year, using the same source as for capital expenditures. This distribution is closer to the distribution assumed for capital expenditures for the program period than that of the base year, but is less concentrated in urban areas. Maintenance expenditures per lane mile are about twice as high in urban areas as rural areas, and the distribution varies over a fairly narrow range in both urban and rural areas ($36 to $44 thousand per lane mile for urban functional classes and $17 to $28 thousand per lane mile for rural classes).

■ 2.4 Attribution of Revenues to Vehicle Classes

Exhibit 12 provides a forecast of Minnesota-based vehicles, separating vehicles which pay highway user taxes at reduced rates from vehicles which pay at standard rates. Reduced-fee vehicles include government vehicles, school buses, transit buses, and farm trucks. Reduced-fee vehicles are a relatively small share of the automobile, motorcycle, and pickup and van classes -- 3.6, 1.4, and 0.8 percent respectively. However, 72 percent of buses and 25 to 30 percent of each truck class are reduced-fee vehicles.

Highway user revenues for FY 1989 and FY 1993 were attributed to standard and reduced-fee vehicles in each vehicle class as follows:

- Fuel tax revenues were attributed based on estimates of vehicle miles of travel on Minnesota highways and fuel economy (miles per gallon) for gasoline and diesel trucks in each vehicle class.

- Registration fees were attributed using detailed breakdowns of collections by type of fee and registered weight provided by the Minnesota Department of Public Safety. The FY 1993 revenue attributions for these fees take into account changes in the depreciation schedules for passenger vehicles, which were implemented in 1990.

- Excise taxes were attributed to vehicle classes using estimates of annual vehicle sales and prices. Sales for each vehicle class in Minnesota were estimated using national data on annual sales as a percentage of the

Exhibit 11. Distribution of State Capital Expenditures by Functional Class for FY 1991-95

Functional Class of Highway	Percent Distribution from 1991-95 Program State & Federal	Percent Distribution State Funds FY 1991-95	FY 1991-95 State Expenditures (millions)
Rural:			
Interstate	6.3%	1.8%	$26.6
Principal Arterial	15.5	19.3	283.0
Minor Arterial	10.5	13.1	191.7
Major Collector	1.3	1.6	23.7
Minor Collector	0.0	0.0	0.0
Subtotal	33.6	35.9	525.0
Urban:			
Interstate	19.5	5.6	82.4
Freeway and Expressway	23.5	29.3	429.0
Other Principal Art.	18.0	22.5	328.6
Minor Arterial	5.3	6.6	96.8
Collector	0.1	0.1	1.8
Subtotal	66.4	64.1	938.6
Total	100.0%	100.0%	$1,463.6

Source: Based on 1987 split between urban and rural and estimates of distribution by functional class within urban and rural areas by MnDOT staff.

Exhibit 12. Forecast of Minnesota-Based Vehicles for FY 1993

	Standard-Fee Vehicles	Reduced-Fee Vehicles	All Vehicles
Automobiles	2,568.0	96.2	2,664.3
Motorcycles	152.5	2.2	154.7
Pickups and Vans	794.3	6.4	800.7
Buses	4.1	10.3	14.3
Single Unit Trucks			
2 Axle	62.9	26.0	89.0
3+ Axle	17.1	7.1	24.2
Combinations			
3 Axle	2.9	1.2	4.1
4 Axle	6.8	2.8	9.6
5 Axle	13.3	5.5	18.7
6+ Axle	1.1	0.4	1.5
All Vehicles	**3,622.9**	**158.1**	**3,781.0**

Source: Study team analysis of Minnesota registration data. Growth from FY 1989 to FY 1993 is projected based on growth rates from the FHWA-Faucett VMT Model and trends in growth in VMT on Minnesota highways.

number of vehicles in each class. These percentages were applied to the number of Minnesota-based vehicles in each class.

- Fees for the various types of drivers licenses issued by Minnesota were attributed in proportion to the number of Minnesota-based vehicles, taking into account which types of licenses are required to operate different types of vehicles.

Exhibit 13 shows the attribution of highway user revenues to standard and reduced-fee vehicles in each vehicle class for FY 1989 and 1993. Highway user revenues increase from FY 1989 to FY 1993 for each vehicle class, although at a rate less than the four percent inflation rate used in projecting FY 1993 revenues. Reduced-fee vehicles account for only about one percent of revenues from the automobiles, motorcycles, and pickups and vans. However, reduced-fee vehicles account for a much higher share of revenues from trucks (10 to 18 percent) and buses (67 percent).

Exhibit 14 shows the distribution of highway user revenue by type of tax for standard-fee vehicles in each class. Fuel taxes account for 35 percent of the revenues from automobiles, 20 percent of the revenue from motorcycles, and over 40 percent for other vehicle classes, ranging up to 57 percent of the revenue from buses. Excluding motorcycles and buses, registration fees account for 26 to 35 percent of the revenue for each class. The importance of excise taxes and drivers' license fees varies inversely with weight. These taxes account for 46 and 14 percent respectively of the revenue from motorcycles but only 14 and less than one half percent of the revenue from five axle combinations.

Exhibit 15 shows FY 1989 and FY 1993 highway user revenue and revenue per vehicle mile for each vehicle class. When viewed on a per vehicle mile basis, highway user revenues decrease or remain constant for all vehicle classes except automobiles. The slight increase in revenue per vehicle mile for autos is due primarily to the 1990 change in depreciation schedules used in calculating registration fees for passenger vehicles. Decreases in revenue per vehicle mile for other vehicle classes are due primarily to projected improvements in fuel economy.

Exhibit 13. Attribution of Revenue to Vehicle Classes

	FY 1989 Revenue (millions)			FY 1993 Revenue (millions)		
	Standard Fee Vehicles	Reduced Fee Vehicles	All Vehicles	Standard Fee Vehicles	Reduced Fee Vehicles	All Vehicles
Automobiles	588.1	10.4	598.5	677.4	11.1	688.5
Motorcycles	5.6	0.0	5.6	6.2	0.0	6.2
Pickups and Vans	205.5	0.9	206.4	225.4	0.9	226.3
Buses	2.3	5.0	7.3	2.5	5.3	7.8
Single Unit Trucks						
2 Axle	24.6	4.9	29.5	27.1	5.5	32.6
3+ Axle	19.0	4.0	23.0	20.7	4.5	25.2
Combinations						
3 Axle	4.1	0.7	4.8	4.5	0.8	5.3
4 Axle	15.1	2.5	17.6	16.2	2.7	18.9
5 Axle	62.5	6.9	69.4	66.4	7.5	73.9
6+ Axle	5.1	0.6	5.7	5.4	0.6	6.0
All Vehicles	**931.9**	**35.9**	**967.8**	**1051.6**	**38.8**	**1,090.4**

Exhibit 14. Distribution of Highway User Revenue by Type of Tax (Percent) for Standard-Fee Vehicles in FY 1993

	Fuel Taxes	Registration Fees	Excise Taxes	Drivers' License Fees	Total
Automobiles	35	35	28	2	100%
Motorcycles	20	21	46	14	100%
Pickups and Vans	53	28	18	2	100%
Buses	57	11	31	2	100%
Single Unit Trucks					
2 Axle	43	33	22	2	100%
3+ Axle	43	33	24	1	100%
Combinations					
3 Axle	54	26	20	1	100%
4 Axle	47	31	23	0	100%
5 Axle	54	32	14	0	100%
6+ Axle	53	32	15	0	100%
All Vehicles	**41**	**33**	**24**	**2**	**100%**

Note: Revenues by government vehicles, farm trucks, and other vehicles with reduced highway user fees are not included in this exhibit.

Exhibit 15. Revenue Per Vehicle Mile for Standard Fee Vehicles

	Revenue per Vehicle Mile (cents)	
	FY 1989	**FY 1993**
Automobiles	2.4	2.5
Motorcycles	1.8	1.8
Pickups and Vans	2.4	2.4
Buses	4.9	4.8
Single Unit Trucks		
2 Axle	3.5	3.4
3+ Axle	7.1	6.8
Combinations		
3 Axle	5.6	5.4
4 Axle	6.0	5.8
5 Axle	5.9	5.5
6+ Axle	5.9	5.6
All Vehicles	**2.6**	**2.7**

Note: Revenues and mileage by government vehicles, farm trucks, and other vehicles with reduced highway user fees are not included in this exhibit.

3.0 Cost Allocation to Vehicle Class

Since transportation planners began doing highway cost allocation studies about fifty years ago, two techniques for building the models have become widely used. They are known as the "Federal Method" and the "Incremental Method." While both methods use the same modeling techniques for most of the transportation system cost components (for example, administration and enforcement) they differ greatly in how they handle pavement costs and bridge costs.

This chapter of the report begins with a discussion of the difference between these two basic techniques. In this study, we analyzed the data using both methods but used the Federal Method as the primary basis for our conclusions and recommendations since this method is more widely accepted and used in recent studies, and is more reflective of current highway research and design practice. Following the method discussion, this chapter describes the cost responsibility and revenue contribution of each vehicle class and shows the equity of Minnesota's current fee structure for these vehicle classes -- i.e., the extent to which some classes are paying more than their fair share and some are paying less. This is followed by a discussion of differences in equity within the heavier vehicle classes as a function of gross weight and annual miles traveled. Finally, the results of the Federal and Incremental Methods are presented and compared.

3.1 The Federal and Incremental Methods

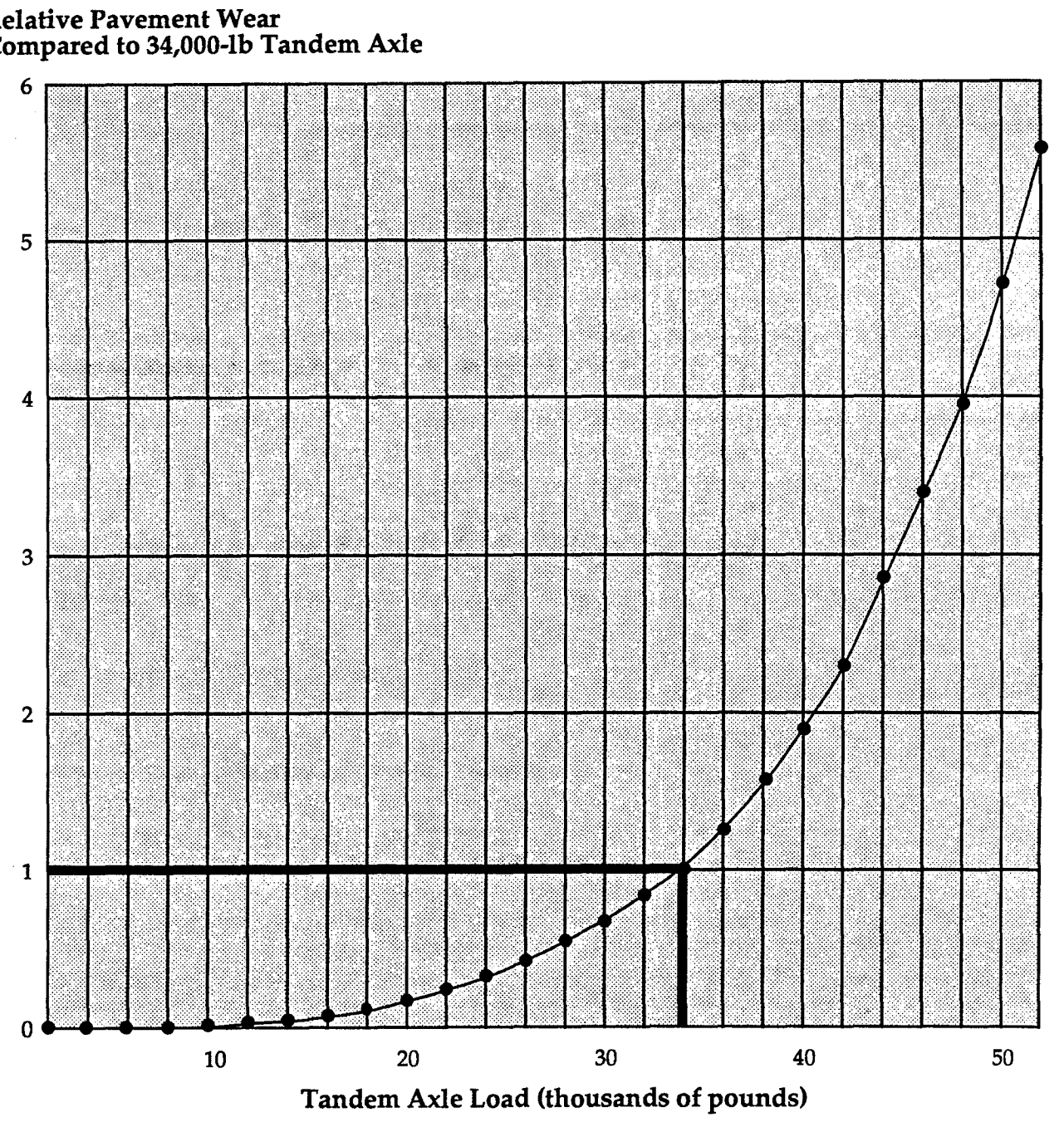
The most widely accepted approach in current cost allocation studies is the set of methods called the Federal Method which was developed and applied by the Federal Highway Administration when it did its 1982 Federal Highway Cost Allocation Study. The Federal Method allocates highway costs on the basis of the contribution that each vehicle class makes to pavement damage and other components of highway deterioration, as well as other components of operation, administration, and enforcement. It has been endorsed by the American Association of State Highway and Transportation Officials (AASHTO), which is the association of all state DOTs and highway agencies. It is a newer method, and one that is more complex in some elements than earlier methods.

The motor carrier industry rejects the Federal Method in favor of the procedures that had been the most used and most widely accepted prior to the 1982 Federal Highway Cost Allocation Study. These procedures have been called the Incremental Method because they assign the basic costs of highways and bridges to all vehicles and assign each increment above those basic costs only to those vehicles that need them. Thus, the cost of the roadbed and first pavement layers are allocated equally among all vehicle classes according to miles traveled and do not consider amount of damage done by each class. The Incremental Method results in assigning lower amounts of costs to heavy trucks than the Federal Method, primarily because of differences in how the two methods handle pavement costs, and to a lesser extent, bridge costs.

In order to understand the difference between the two pavement allocation methods, the role of axle loads must be understood. Axle loads are a critical factor in cost allocation studies because of the fact that pavement wear increases greatly as axle loads increase. Wear increases approximately in proportion to the fourth power of axle weight, so that an axle that is twice as heavy as another causes about 16 times as much wear. Exhibit 16 shows the effect of increasing axle weight on pavement wear by expressing the wear caused by a pair of tandem axles of any weight as a function of the wear caused by tandem axles at the Federal limit of 34,000 pounds. We focus attention on tandem axles because they are the most common heavy axle loads, such as those on three axle single unit trucks and five axle tractor-semitrailers.

Because of this relationship, careful attention has been devoted to the analysis of the axle loads for each vehicle type on each class of highway using extensive tabulations of truck weight data collected by Minnesota since the early 1980s.

Exhibit 16. Relationship Between Pavement Wear and Tandem Axle Loads



The Federal Method allocates pavement costs based upon the estimated strength required, or the damage to pavements imposed by the axle loads of each vehicle type, without regard to whether vehicles are basic design vehicles (i.e., autos and other light vehicles) for a minimum pavement thickness or heavier vehicles imposing added pavement thickness costs. The Federal Method for new pavements is consistent with modern pavement design practices and the procedure used for pavement rehabilitation is based on the results of new models that simulate the effects of various factors on different types of pavement distress.

In contrast, the Incremental Method allocates pavement costs through a procedure of first assigning costs to all vehicles for a minimum thickness pavement designed to serve light vehicles only, and then assigning the incremental costs of making pavements thicker to serve heavier vehicles to the heavier vehicles only. This approach is consistent with an evolutionary view of highway development. In general, weight limits have been allowed to increase from time to time under principles of engineering economics when the benefits to be derived by the trucking industry are greater than the incremental pavement and other highway costs incurred. Of course, the key to equity in such decisions is that the incremental highway costs should be paid for by those benefiting from the weight limit increases. This is the essence of the Incremental Method.

Proponents of the Federal Method argue that the Incremental Method gives all the economy of scale in making thicker pavements to just the heavier vehicles. The incremental costs of thicker pavements decreases rapidly as each inch of thickness is added. The Federal Method shares this economy of scale among all vehicle classes because each unit of wear to the pavement is charged the same amount of user fees whether that unit of damage is imposed by a large or a small vehicle. Proponents of the Incremental Method argue that the roads would be built anyway for basic vehicles and the way of charging heavier vehicles is to make them pay for the incremental cost of accommodating heavier vehicles (as well as a share of the basic pavement cost in proportion to their share of use of the highway).

Industry representatives have also argued that light vehicles benefit from an economy of scale in that stronger pavements are being necessitated by heavier axle loads and that the incremental cost to all highway users of added thickness and longer pavement life is therefore less because of the existence of the heavier vehicles. This latter argument has not been subjected to careful scrutiny and analysis.

A shortcoming of the Incremental Method as applied in the past is that pavement rehabilitation costs were allocated in the same manner as new pavement costs. When the Incremental Method was developed, most pavement expenditures, particularly at the Federal level, were for new pavements. However, this is increasingly untrue and the Incremental Method has thus been more and more out of step with actual highway expenditure

patterns. In this study a new procedure has been applied that allocates pavement rehabilitation costs in a manner consistent with both contemporary design practices for pavement overlays and the principles on which the Incremental Method is based.

The Federal Method for bridges includes a procedure that recognizes that heavier vehicles often contribute more to the need to replace bridges when their load carrying capacity diminishes. This is an important item lacking from the Incremental Method because an increasingly significant proportion of bridge expenditures are for bridge replacements, as distinct from new bridges, for which the Incremental Method was originally developed.

Each of the two methods yields the same results in the allocation of cost categories other than pavements and bridges, since the procedures in the Incremental Method were adapted for the Federal Method. Maintenance, operations, enforcement, and motor vehicle administration are assigned to vehicle types in the same manner under either method. Thus, the level of difference in the results of cost allocations between these two basic methods depends on the specific amounts and categories of the expenditures to be allocated. If pavement construction, rehabilitation, and bridge programs are large items, the two methods will yield very different results.

State Aid and other local expenditures have been allocated among vehicle classes as an extension of the results of the allocation of State expenditures for each type of highway expenditure. The main difference in the results at the local level is that the mix of traffic is much different on roads of local responsibility. A much lower proportion of five or more axle combinations occurs and this lowers that group's cost responsibility greatly. The reverse is true for autos, other light vehicles, and single unit trucks. These vehicle classes make up a higher proportion of traffic on State Aid and local roads and therefore have a greater share of overall cost responsibility for these roads.

Both the Incremental and Federal Methods have been applied for Minnesota. Since the major interests concerned with the outcome of the study will probably include those who favor each of these methods, a full comparison can show the implications of choosing one method versus the other on the relative cost responsibility of the vehicle classes. However, the Federal Method results have been used for the basic presentation of findings and recommendations because that method is more widely accepted and used in recent studies, and is more reflective of current highway research and design practice.

Exhibit 17 provides a comparison of the specific procedures that are used under both the Federal and Incremental Methods. These procedures have been followed in developing the results presented below. They will be completely documented in a more detailed technical appendix.

Exhibit 17. Methods for Allocation of Capital Expenditures

Cost Category	Federal Method	Incremental Method
New Pavements	Minimum Pavement Thickness Method	Incremental Analysis of Pavement Thickness
Pavement Rehabilitation	Pavement Consumption Method	Incremental Analysis of Pavement Thickness
New Bridges	Incremental Analysis of Bridge Strength	Incremental Analysis of Bridge Strength
Bridge Replacement	Incremental Analysis of Bridge Strength and Special Bridge Replacement Function	Incremental Analysis of Bridge Strength
Bridge Repair	Common Cost*	Incremental Analysis of Bridge Strength
Grading for New Facilities	Incremental Analysis of Earthwork Requirements	Incremental Analysis of Earthwork Requirements
Preliminary and Construction Engineering	Prorate Based on Other Capital Outlays for Construction	Prorate Based on Other Capital Outlays for Construction
Right-of-Way and Other Misc. Capital Costs	Common Cost*	Common Cost*

* Common costs were allocated to vehicle classes in proportion to vehicle miles of travel.

3.2 Cost Allocation Results

Exhibit 18 shows the cost responsibility of the vehicle classes for capital outlays of State funds for Trunk Highways under the Federal Method for FY 1989.

A major factor in the high cost responsibility for heavy truck classes is the very large proportion of State expenditures for new pavements and pavement rehabilitation. Minnesota's pavement costs are a high proportion of total expenditures because the relatively level terrain reduces costs for other highway items such as grading, drainage, and bridges. Deeper frost penetration also accounts for part of the high cost of new pavements. Minnesota has design standards that require thicker pavement structures than many states because of the deep frost penetration.

Exhibit 19 summarizes the results of the cost allocation for all State-level expenditures. Very large shares of pavement maintenance expenditures have been assigned to heavier vehicles in accord with the wear estimated to be due to axle loads. However, most maintenance expenditures are for other activities (e.g., winter maintenance, drainage, bridges, signs and signals, guard rails, and pavement markings) that are not related to axle loads. Most, but not all of these expenditures are either specifically related to traffic in general or are unrelated to vehicle characteristics and use in any manner (called "common costs"). Accordingly, most of these costs are allocated in proportion to vehicle miles of travel (VMT) of the vehicle classes.

Most other State programs have also been allocated in proportion to VMT on the different highway classes, for the same reason as maintenance. The exceptions are special programs related to commercial vehicles, such as weight enforcement, hazardous materials regulation, commercial vehicle inspection, and the collection and enforcement of truck taxes and fees. Costs of these programs have been allocated in proportion to VMT for truck classes only.

State Aid expenditures (which include the State portion of the Federal-County Road and Bridge Program and transit assistance) have been allocated based primarily on the assumption that the cost per vehicle mile relative to auto costs per vehicle mile is the same for each vehicle class at the local level as it is at the State level. Thus, the primary difference between State and local cost allocation results is due to differences in levels of expenditures for the various program categories and differences in VMT of the vehicle classes on the two highway systems. Transit assistance has been allocated proportionately among urban Trunk Highway VMT.

Exhibit 18. State Trunk Highway Cost Responsibility of Vehicle Classes for Capital Outlays (costs in millions of dollars for FY 1989)

Vehicle Class	Pavements	Bridges	Other	Total
Automobiles	$60.2	$ 8.8	$79.1	$148.1 (1.0¢/mi.)
Motorcycles	0.7	0.1	1.0	1.7 (0.9¢/mi.)
Pickups and Vans	18.8	3.2	23.4	45.4 (1.0¢/mi.)
Buses	1.8	0.3	0.6	2.8 (2.8¢/mi.)
Single Unit Trucks				
2 Axle	6.5	1.0	2.6	10.1 (2.4¢/mi.)
3+ Axle	4.1	0.7	1.1	5.9 (4.0¢/mi.)
Combinations				
3 Axle	1.2	0.2	0.4	1.7 (2.9¢/mi.)
4 Axle	5.0	0.8	1.4	7.2 (3.6¢/mi.)
5 Axle	42.2	4.8	7.4	54.4 (5.7¢/mi.)
6+ Axle	4.2	0.5	0.6	5.3 (7.5¢/mi.)
All Vehicles	**$144.7**	**$20.4**	**$117.4**	**$282.5 (1.3¢/mi.)**

Note: Values in parentheses are cost responsibilities in cents per vehicle mile on Minnesota Trunk Highways.

Exhibit 19. Cost Responsibility of Vehicle Classes for All State Highway Expenditures (costs in millions for FY 1989)

	State Capital Outlays	State Maintenance	Other State Programs	State Aid	Total Expenditures
Automobiles	$148.1	$70.6	$114.2	$235.9	$568.8 (3.8¢/mi.)
Motorcycles	1.7	0.9	1.4	2.8	6.9 (3.7¢/mi.)
Pickups and Vans	45.4	24.6	33.8	90.2	194.1 (4.4¢/mi.)
Buses	2.8	0.9	0.8	4.1	8.6 (8.5¢/mi.)
Single Unit Trucks					
2 Axle	10.1	3.7	3.3	12.5	29.6 (6.9¢/mi.)
3+ Axle	5.9	1.9	1.8	7.9	17.5 (11.7¢/mi.)
Combinations					
3 Axle	1.7	0.5	0.7	1.3	4.2 (7.1¢/mi.)
4 Axle	7.2	2.1	2.4	5.0	16.7 (8.4¢/mi.)
5 Axle	54.4	15.9	11.5	23.8	105.6 (11.1¢/mi.)
6+ Axle	5.3	1.6	0.9	3.4	11.2 (15.8¢/mi.)
All Vehicles	**$282.5**	**$122.9**	**$170.8**	**$386.9**	**$963.1 (4.5¢/mi.)**

Note: Values in parentheses are cost responsibilities in cents per vehicle mile on Minnesota Trunk Highways.

Exhibits 18 and 19 provide a basis for comparing the proportions of expenditures allocated to heavier vehicle classes for different types of expenditures. The highest proportions of expenditures are allocated to heavy trucks for pavements. This is because axle loads are the key factor in these methods. The next highest proportions are allocated to heavy trucks for bridges. Gross weight of vehicles is the key factor in the method used for allocating bridge costs. Other capital costs are next, primarily because a portion of grading and drainage costs are influenced by the need to reduce grades on higher design highways to accommodate heavier trucks which cannot climb long, steep grades as easily as lighter vehicles. Maintenance costs have a somewhat higher proportion allocated to heavier trucks than other State programs because pavement maintenance costs are allocated largely on the basis of axle loads; whereas, only a small proportion of other State programs are exclusively truck-related (e.g., weight enforcement, hazardous materials monitoring, truck safety inspections, and administration of commercial vehicle taxes and fees). The vast majority of other program expenditures have been allocated to all vehicle classes on the basis of VMT, the factor that is generally used for allocating costs that cannot be related to specific vehicles or vehicle characteristics.

For State Aid expenditures, combination trucks have relatively low shares of cost responsibility because they have a very low proportion of their mileage on local streets and roads. Single unit trucks have a much larger share of their mileage on local routes, and therefore much higher shares of cost responsibility than under State programs.

■ 3.3 Revenue-to-Cost Responsibility Ratios

Exhibit 20 summarizes the data on which the revenue-to-cost responsibilities are based. The first column (taken from Exhibit 13) shows the total revenues projected to be paid by owners or users of each of the ten vehicle classes for Fiscal Year 1989. These include fuel taxes, registration fees, drivers' licenses, motor vehicle excise tax, and all other state-collected fees that are paid uniquely by highway users. The second column (taken from Exhibit 19) shows the estimated cost responsibility of each vehicle class for FY 1989. This cost responsibility is the estimated fair share of the costs of all State-managed highway programs, including highway construction and maintenance, highway patrol, commercial vehicle enforcement and safety programs, motor vehicle administration, drivers' license administration, and highway and transit assistance to local governments.

The third column of Exhibit 20 shows the unadjusted ratio of revenues to cost responsibility for each vehicle class -- the first column divided by the second column -- for FY 1989. The ratios presented may be called equity ratios.

Exhibit 20. Equity of Minnesota Highway Tax Structure as Measured by Revenue-to-Cost-Responsibility Ratios for FY 1989

Vehicle Class	Highway User Revenues FY 1989 (millions)	FY 1989 Cost Responsibility (millions)	Unadjusted Revenue-to-Cost-Responsibility Ratios	Adjusted Revenue-to-Cost Responsibility Ratios
Automobiles	$598.5	$568.8	1.05	1.05
Motorcycles	5.6	6.9	0.82	0.82
Pickups and Vans	206.4	194.1	1.06	1.06
Buses	7.3	8.6	0.85	0.85
Single Unit Trucks				
2 Axle	29.5	29.6	1.00	0.99
3+ Axle	23.1	17.5	1.32	1.31
Combinations				
3 Axle	4.8	4.2	1.14	1.13
4 Axle	17.5	16.7	1.05	1.04
5 Axle	69.5	105.6	0.66	0.66
6+ Axle	5.6	11.2	0.50	0.50
All Vehicles	**$967.9**	**$963.1**	**1.00**	**1.00**

Notes:
(1) All amounts are in millions of 1989 dollars.
(2) This exhibit covers State-collected funds for State highway programs plus State-collected funds used for all State Aid and other local assistance for roads and transit. It includes not only highway user taxes and fees dedicated to the various transportation funds, but also includes State-collected taxes on highway users that go into the General Fund (a portion of the motor vehicle excise taxes and drivers' license fees).
(3) Total State-collected highway user revenues are slightly greater than total State program cost responsibility. Highway user revenues that go into the General Fund are $4.8 million greater than General Fund amounts that are spent for highway-related programs.
(4) Federal aid to Minnesota, expenditures of Federal funds, and Federal taxes paid by Minnesota highway users are excluded from this exhibit. Also excluded are local expenditures from non-highway user sources.
(5) The adjusted ratios above are based on adding 97.2 percent of highway user revenues paid into the General Fund by each vehicle class to all the highway user revenues paid into the transportation funds, so that revenues exactly equal total State expenditures for highways.

Equity ratios of more than 1.00 indicate that a vehicle class is paying more than its share of cost responsibility in State highway user taxes and fees for the overall highway program, including local assistance programs. An equity ratio of 1.00 indicates that a vehicle class is exactly paying its share of cost responsibility in State taxes and fees, and anything lower indicates that a vehicle class is paying less than its share.

A slight problem occurs with the use of the unadjusted revenue-to-cost responsibility ratios in that it ignores the fact that total state highway user revenues in the first column exceed total State highway expenditures in the second column, and that the excess revenue should not logically be treated as excess user payments when local programs are considered. Large amounts of State General Fund revenues are used for streets and highways at the local level (an estimated $124 million in FY 1989). If these local expenditures are accounted for, total State-collected highway user revenues do not cover all State highway-related aid and expenditures. Therefore, it is not reasonable to credit all State-collected highway user taxes to cover programs directly managed by the State.

For this reason, an adjusted equity ratio is shown in the last column of Exhibit 20. The total highway user revenues in this calculation exactly equal total highway-related expenditures directly managed by the State (i.e., the total of State Trunk Highways plus State Aid and other local assistance programs, as shown in column two). To force total revenues to match total expenditures in this last column, 97.2 percent of the highway user revenues paid into the General Fund by each vehicle class (portions of the excise tax and drivers' license fees) are added to the highway user revenues paid into the transportation funds.

Under the Federal Method, four vehicle classes are significantly underpaying: motorcycles, buses, and the two largest classes of combination trucks. Autos, pickups and vans, two axle single unit trucks, and three and four axle combinations are paying their fare share or moderately overpaying. Three or more axle single unit trucks are significantly overpaying.

Exhibit 21 provides additional equity ratios, all calculated on a different basis using the Federal Method. The first column repeats the last column from Exhibit 20 for comparison purposes.

The second column shows how the ratios change when all reduced-fee-paying vehicles are removed from each vehicle class. These include some completely tax exempt vehicles, some that are tax exempt from certain fees but not others, and others (the largest category) that pay reduced fees. The equity ratio for standard-fee-paying buses is higher than all buses because the taxes and fees paid by those removed do not cover their cost responsibility. However, standard-fee-paying trucks of all classes have somewhat lower equity ratios than in the first column of the exhibit because the primary category that has been removed is farm trucks, which have reduced registration fees but travel

Exhibit 21. Equity of Minnesota Highway Tax Structure as Measured by Alternative Revenue-to-Cost-Responsibility Ratios

Vehicle Class	All Vehicles FY 1989	Standard-Fee-Paying Vehicles FY 1989	All Vehicles State + Federal FY 1989	All Vehicles State + Federal + Local FY 1989	All State Vehicles FY 1991-95
Automobiles	1.05	1.05	0.90	0.57	1.04
Motorcycles	0.82	0.82	0.66	0.41	0.78
Pickups and Vans	1.06	1.06	1.04	0.51	1.05
Buses	0.85	1.09	0.69	0.36	0.79
Single Unit Trucks					
2 Axle	0.99	0.90	0.97	0.48	0.97
3+ Axle	1.31	1.18	1.80	0.77	1.33
Combinations					
3 Axle	1.13	1.06	1.42	1.07	1.12
4 Axle	1.04	0.98	1.34	1.00	1.03
5 Axle	0.66	0.64	0.88	0.76	0.67
6+ Axle	0.50	0.49	0.72	0.61	0.54
All Vehicles	**1.00**	**1.00**	**0.95**	**0.58**	**1.00**

fewer annual miles than standard-fee-paying trucks and therefore have lower cost responsibility. Note that the ratios in this column have been adjusted so that the ratio for all vehicles is 1.00, as was done for the ratios in the first column.

The major conclusions that are different from the initial conclusions, based on the analysis of standard- and reduced-fee paying vehicles, are that standard buses are significantly overpaying, and that standard two axle trucks are significantly underpaying.

The third column of Exhibit 21 adds in Federal revenues paid by Minnesota highway users and cost responsibility for Federal expenditures in Minnesota. All State-level highway user revenues have been included in this analysis as well. Despite this, note that the ratio for all vehicles is somewhat below 1.00. This is because Minnesota receives significantly more in Federal Aid than is paid in Federal highway user taxes. Note that autos are underpaying in this combined analysis and that most truck classes have higher equity ratios than in the first column of the exhibit. The changes in the ratios in the third column can be explained by the fact that Federal expenditures are concentrated more on bridge projects, right of way, and miscellaneous construction activity, and less on pavements compared with State expenditures. However, we do not recommend that this combined analysis be used for judging the equity of Minnesota's tax structure because Federal tax policy is the jurisdiction of Congress and Minnesota tax policy is the jurisdiction of the Legislature.

The fourth column of Exhibit 21 adds in local expenditures from local sources and the State General Fund. The only State or local highway user revenues added in which were not included in the first column are those that are paid into the General Fund and that are in excess of what was needed to match State-level expenditures in the first column. This analysis shows that Minnesota highway users are paying only 60 percent of highway-related expenditures by all levels of government, and that most, of the vehicle classes are substantially underpaying. However, for the same reason cited above, we do not recommend using this analysis for judging the equity of the State tax structure.

The last column of Exhibit 21 presents equity ratios for the program period, FY 1991-95, calculated on the same basis as the first column. This shows that single unit three or more axle trucks are expected to be continuing to overpay substantially in the future under the current tax structure while five or more axle combinations and motorcycles will continue to underpay substantially. Automobiles, pickups and vans, two axle single unit trucks, and three and four axle combination trucks will be continuing to pay their share or somewhat more. Buses as a whole will be substantially underpaying, but when transit and school buses are removed from the analysis, other buses that pay standard taxes and fees will be approximately paying their share. All of these changes from the ratios shown in column one of Exhibit 21 can be

explained by the expanded???? shift in program emphasis away from heavy investment in the Interstate system to more balance among functional classes.

The values in this last column are the basis for the bars shown in Exhibit 1 in the section on Key Findings and Recommendations.

■ 3.4 Effects of Various Factors on Equity

Of necessity, the basic analysis has had to focus on vehicle classes defined in accord with the best data available on the mix of vehicles using the highway system -- the vehicle classes defined primarily by axle configuration. However, the factors that affect cost responsibility most within these vehicle classes -- gross weight and annual mileage -- should be taken into account carefully in considering the equity of the tax structure.

The most important basic relationships involved are well understood. Cost responsibility for pavements increases in relation to axle weights approximately as the fourth power of weight, as was illustrated in Exhibit 16. Also, most highway costs increase in direct proportion to miles traveled per vehicle. However, data are not readily available on some key factors affecting revenues and cost responsibility of vehicles within truck classes, such as how annual mileage varies by gross registered weight, how actual operating weight and axle weights vary by gross registered weight, and how the percent of annual mileage in Minnesota varies by gross registered weight. Despite these data problems, before completing the project and the final report we will be making estimates of revenues and cost responsibility for selected special classes of vehicles using the best available data from all sources -- including national sources, data from the Census, and data from other states. These special classes of vehicles may include carriers operating in important Minnesota industries, carriers that operate with high empty backhaul mileage, and high gross weight trucks.

■ 3.5 Comparison of Federal and Incremental Method Results

Exhibit 22 shows comparative results of the Federal and Incremental Methods. To facilitate comparison of results between the two methods as well as among the categories of expenditures for which the methods differ, the cost allocation results have been presented in the first six columns. The last two columns compare the overall revenue-to-cost responsibility ratios for the two methods for each vehicle class.

Exhibit 22. Comparison of Federal Method and Incremental Method Results (costs in millions of dollars for FY 1989)

	Cost Responsibility						Revenue-to-Cost-Responsibility Ratios	
	Federal Method			Incremental Method				
Vehicle Class	Pavements	Bridges	State Aid	Pavements	Bridges	State Aid	Federal Method	Incremental Method
Automobiles	$ 60.2	$ 8.8	$ 235.9	$ 67.7	$10.7	$237.8	1.05	1.03
Motorcycles	0.7	0.1	2.8	0.8	0.1	2.8	0.82	0.80
Pickups and Vans	18.8	3.2	90.2	22.9	3.4	91.9	1.06	1.03
Buses	1.8	0.3	4.1	2.0	0.2	4.2	0.85	0.85
Single Unit Trucks								
2 Axle	6.5	1.0	12.5	7.1	0.7	12.5	0.99	0.99
3+ Axle	4.1	0.7	7.9	3.4	0.5	7.2	1.31	1.45
Combinations								
3 Axle	1.2	0.2	1.3	1.7	0.1	1.4	1.13	0.99
4 Axle	5.0	0.8	5.0	6.0	0.5	5.4	1.04	0.98
5 Axle	42.2	4.8	23.8	29.9	3.8	20.7	0.66	0.78
6+ Axle	4.2	0.5	3.4	3.3	0.4	3.1	0.50	0.56
All Vehicles	**$144.7**	**$20.4**	**$386.9**	**$144.7**	**$20.4**	**$386.9**	**1.00**	**1.00**

By far the largest differences between results for the two methods are in the pavement cost allocations. Cost responsibility for autos under the Incremental Method is more than seven million dollars greater than it is for the Federal Method. This accounts for a large part of the differences in the equity ratios. The reverse is true for some of the truck categories, with the biggest difference being for five axle combination trucks -- the Federal Method results in about twelve million dollars more cost responsibility than the Incremental Method. The proportionate differences are also large for other heavier truck classes.

The Incremental Method, which was originally developed for allocating only the costs of new pavements, has been found in a recent study by the consultant team to allocate an unrealistically low share of cost responsibility for pavement rehabilitation to heavy trucks. Because of the high percentages of new pavement costs that are required to satisfy Minnesota's frost design standards, new pavement costs are overwhelmingly allocated to light vehicles under the Incremental Method. In reality, Minnesota's frost design standards for new pavements should have little bearing on the allocation of pavement rehabilitation costs. For this reason, a revision to the Incremental Method for pavement rehabilitation costs has been applied based on recent design procedures for pavement overlays. This new procedure is consistent with the traditional Incremental Method otherwise.

Note that large differences between the Federal and Incremental Methods also occur in the allocation of State Aid expenditures. The large differences between the two methods for the State Aid reflects the fact that a very high proportion of these expenditures are for pavements -- higher than at the State level. For heavier classes of trucks the differences between the two methods are therefore proportionately larger at the local level for capital outlays.

The differences between the two methods are generally somewhat more moderate for bridge expenditures. This is partly because the procedures used in both methods are identical for the allocation of new bridge costs. The differences are moderate also, in part, because the results partially offset each other for the other two categories of bridge expenditures -- bridge replacements and bridge rehabilitation. A higher share of bridge replacement costs under the Federal Method are allocated to heavy vehicles in recognition of the fact that a significant proportion of the reason for replacing older bridges is due to reductions in their load carrying capacity. On the other hand, the Federal Method allocates bridge rehabilitation costs to all vehicles equally on a mileage basis, because almost none of these costs are due to weight or other vehicle characteristics; whereas, the Incremental Method allocates all bridge costs in the same manner as new bridge costs -- in proportion to the incremental costs of building bridges for incrementally greater vehicle weights.

Despite the significant differences between the results of the two methods, the conclusions that can be drawn from the two are essentially the same regarding vehicle classes that are substantially underpaying or overpaying.