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The Denver RTD Off-Peak Free Fare Transit Demonstration

Final Report
March 1980

Service and Methods Demonstration Program

U.S. DEPARTMENT OF TRANSPORTATION
Urban Mass Transportation Administration and
Research and Special Programs Administration
Transportation Systems Center

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16. Abstract

In February 1978, the Denver RTD eliminated the 25 cent off-peak fare and retained a 50 cent peak hour fare for bus boardings during the morning (2 hours) and evening (2 hours) rush hours. This experiment in innovative transit pricing continued for one year as a federally assisted demonstration project to determine the effects of free off-peak transit in a major urban area.

This report summarizes the evaluation of the Denver experiment with respect to the implementation requirements of no fare off-peak bus service and its effects on 1) travel behavior and transit's share of metropolitan tripmaking; 2) bus operations, quality of service, transit costs and revenues; and 3) indirect effects on the environment, energy consumption, and public support for transit. The extensive data collection activities conducted by RTD as part of the demonstration, including transit operations monitoring, surveys of transit users on-board and follow-up telephone, and general population surveys are documented and their results analyzed. Principal findings of the evaluation are reported and their implications for transit pricing and service planning discussed.

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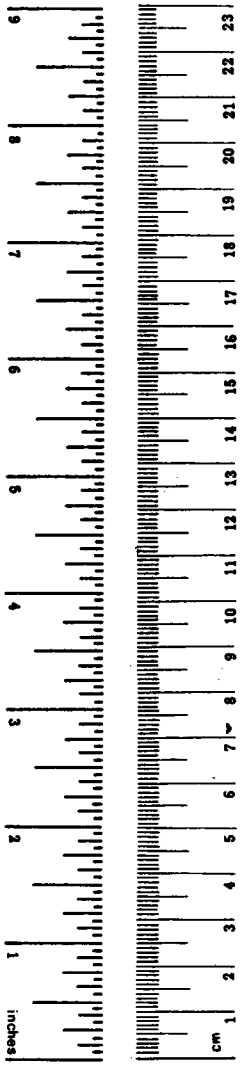
METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
	AREA			
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	square miles	2.6	square kilometers	km^2
	acres	0.4	hectares	ha
	MASS (weight)			
oz	ounces	28	grams	g
lb	pounds	0.45	kilograms	kg
	short tons (2000 lb)	0.9	tonnes	t
	VOLUME			
tsp	teaspoons	5	milliliters	ml
Tbsp	tablespoons	15	milliliters	ml
fl oz	fluid ounces	30	milliliters	ml
c	cups	0.24	liters	l
pt	pints	0.47	liters	l
qt	quarts	0.95	liters	l
gal	gallons	3.8	liters	l
ft^3	cubic feet	0.03	cubic meters	m^3
yd^3	cubic yards	0.76	cubic meters	m^3
	TEMPERATURE (exact)			
°F	Fahrenheit temperature	5/9 (after subtracting 32)	Celsius temperature	°C

*1 in = 2.54 (exactly). For other exact conversions and more detailed tables, see NBS Misc. Publ. 286, Units of Weights and Measures, Price $2.25, SD Catalog No. C13.10:286.



Approximate Conversions from Metric Measures

Symbol	When You Know	Multiply by	To Find	Symbol
	LENGTH			
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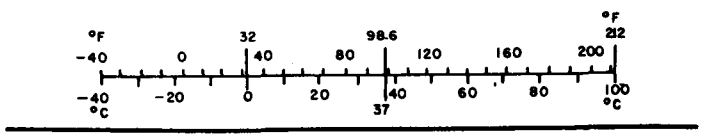
cm	centimeters	0.4	inches	in
m	meters	3.3	feet	ft
m	meters	1.1	yards	yd
km	kilometers	0.6	miles	mi
	AREA			
cm^2	square centimeters	0.16	square inches	in^2
m^2	square meters	1.2	square yards	yd^2
km^2	square kilometers	0.4	square miles	mi^2
ha	hectares (10,000 m^2)	2.5	acres	
	MASS (weight)			
g	grams	0.035	ounces	oz
kg	kilograms	2.2	pounds	lb
t	tonnes (1000 kg)	1.1	short tons	
	VOLUME			
ml	milliliters	0.03	fluid ounces	fl oz
l	liters	2.1	pints	pt
l	liters	1.06	quarts	qt
l	liters	0.26	gallons	gal
m^3	cubic meters	35	cubic feet	ft^3
m^3	cubic meters	1.3	cubic yards	yd^3
	TEMPERATURE (exact)			
°C	Celsius temperature	9/5 (then add 32)	Fahrenheit temperature	°F



PREFACE

This report presents findings of the evaluation of the Denver RTD (Colorado) systemwide off-peak free fare transit demonstration. The demonstration began on February 1, 1978, and continued for 12 months, ending on January 31, 1979. The project included investigation of the effects of eliminating off-peak fares on ridership, transit operations and costs, user characteristics, public attitudes, and regional travel.

The project was sponsored under the Urban Mass Transportation Administration's (UMTA) Service and Methods Demonstration (SMD) program, under authorization from Title II of the National Mass Transportation Assistance Act of 1974. The evaluation was conducted by De Leuw, Cather & Company for the Transportation Systems Center (TSC) of the U.S. Department of Transportation under Technical Task Directive DOT-TSC-1409-15. The principal researcher for the evaluation project was Bob Donnelly; the report was co-authored by Bob Donnelly, Pat M. Gelb, and Paul Ong.

Acknowledgment is also due to other persons for their assistance and cooperation during the demonstration project and the evaluation period: Bruce Spear, Technical Monitor--Transportation Systems Center; John Gaudette (and Staff), Assistant General Manager and Director of the Office for Policy Analysis--RTD; other RTD Staff too numerous to mention; Stewart McKeown, SMD project manager--UMTA. Acknowledgment is also due to several current and former De Leuw, Cather & Company staff members for their assistance in the evaluation: Sherrill Swan, Bob Knight, Steve Colman, Tom Stone, Dave Connor, and Gordon Shunk.

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EXECUTIVE SUMMARY

The Denver Free Fare Transit Demonstration was a test of the effects of eliminating a 25 cent fare during the non-peak periods of bus service. The peak fare of 50 cents remained in effect during the off-peak free fare program. The federally assisted program was conducted for one year by the Regional Transit District (RTD) on all regular service routes, during weekday off-peak hours (all times of day other than between 6-8 a.m. or 4-6 p.m.) and all day Saturday and Sunday. The demonstration was implemented to gain new information about many of the unknown impacts which a limited no fare transit program would have in a major urban area.

The principal conclusion of this evaluation is that free fare transit may be a more effective short-term marketing instrument than a desirable permanent element of transportation policy for metropolitan areas. Reduced or low fare off-peak transit may achieve many of the same beneficial objectives of no fares, but complete removal of the fare barrier appears to generate enough undesirable side effects to undermine its overall effectiveness.

The important positive and negative impacts of the Denver free fare experiment may be summarized as follows:

Implementation Requirements

The free fare demonstration evolved from a period of uncertainty during the Spring of 1978 when the locally initiated "Transit Awareness Month" was extended several times prior to local and federal agreement on its ultimate fate as a one year demonstration project. RTD had just implemented a new fare structure in January. Also during this time, a large shipment of new motor coaches was being received and absorbed into service. Substantial increases in service as part of the March run-board changes were also made, along with the route restructuring changes implemented in Boulder and the Northeast section of Denver during that same month. In addition, RTD staff was preparing for the comprehensive route changes that were planned in September 1979. The effects of the route restructuring project is the subject of a second report prepared as part of Denver demonstration evaluation.

The principal conclusion regarding the implementation process of off-peak free fare program is that substantial planning and allocation of marketing resources are needed to minimize problems inherent in a major free fare program. Due to the numerous competing demands on RTD resources at the time of project implementation, some problems experienced were more severe and difficult to deal with effectively than they may have been without such limitations.

Limitations in staff time and budgetary resources also precluded extensive coordination between the free fare program and other local transit-related efforts, such as the federal employee flextime program. RTD attempted to provide marketing materials to downtown businesses, urging shoppers to use the bus during the free off-peak period, but no full-scale, coordinated promotion was carried out.

On the other hand, the effectiveness of RTD's promotion of monthly passes and tokens in conjunction with the reinstatement of fares demonstrates the potential for widescale coordination and success which exists when there are resources to take advantage of it. RTD had ample lead time to plan for the termination of free fares, to adopt a public policy position on fare reinstatement and to market its money-saving options in cooperation with local retailers.

Impacts on Transit Users

The most dramatic impact of the program was a large increase in weekday off-peak ridership (50%); Saturday (50%) and Sunday (100%). Overall, RTD served 34.3 million trips during the one year demonstration (118,500 total typical weekday trips); 8.2 million more than would have occurred with off-peak fares in effect (26,000 additional typical weekday trips).*

Total bus travel during a typical week, including both peak and off-peak periods, was 32 percent higher than projected base ridership without free fares. Approximately 70 percent of the 671 thousand bus trips made each week were made during the free hours of service. Off-peak ridership, including the weekend increased by an estimated 52 percent during a typical week.

While the impact on transit ridership was dramatic, the overall effect on transit's share of regional travel was modest. The effect of the demonstration was to increase the portion of the 3.8 million weekday intra-regional trips captured by transit from about 2.4 percent to 3.1 percent of total. However, the impact on travel to and from the downtown was somewhat greater with the buses carrying around 11 percent of all CBD trips during the demonstration. It is estimated that less than 9 percent of CBD trips would have been made by transit without off-peak fare elimination.

*As explained in the body of the report, numerous adjustments to the passenger count data available from RTD were required in order to reduce potential estimation error. Consequently, the ridership estimates used in this evaluation in some cases differ from those records maintained by RTD.

Ridership gains due to the no fare incentive were relatively rapid. After accounting for all apparent factors affecting bus ridership during the demonstration period, it is estimated that the maximum free fare ridership growth effect was achieved in the third month of the program. About 85 percent of the maximum impact was obtained after one month. This suggests that a relatively short free transit promotion will accomplish much of the short-run ridership impact that would occur with a long-term program such as tried in Denver.

It is estimated that RTD ridership in the five months following the reinstatement of the 25 cent (reduced) off-peak fare was about 7 percent higher than it would have been had the demonstration never occurred. However, it is difficult to isolate the residual effects of the free fare promotion or ridership from other post-demonstration factors. Analysis of retail gasoline price increases in the Spring of 1979, and area traveler survey indicates that the energy availability and price constraints on automobile use probably had a larger impact on post-demonstration ridership levels. Estimated free fare ridership retention declined the first month after the end of the free fares from about 30 percent of free fare transit trip increases, to an apparent long-term level of about 15 percent by the third month.

While free fares attracted some entirely new riders to transit, the number of persons representing an expansion of the transit user market was relatively small -- about 10 percent of weekly free fare users or about 10 to 20 thousand persons out of the total regional population of about 1.6 million. Most new bus trips resulted from increased bus use by prior bus users. About one-half of the new trips attributable to the free fare policy were previously made by some other mode (predominately auto), one third were former peak bus trips, and one sixth were entirely new travel induced by the fare incentive program.

Increased bus use was somewhat greater among the more affluent, younger, white, and less transit dependent socio-economic groups, but overall the ridership profile of off-peak bus users remained virtually unchanged. Mobility increases (induced trips) were small, but free transit did expand the travel choices of the 10 percent of the population that used RTD during a typical week of the program. The most significant direct benefits of the program were the fare savings accrued by free transit users. The average household needed only to make about one free transit trip per month to recover the additional tax burden imposed on it by the local share of the program costs. However, over the life of the program, transit users became increasingly negative about overcrowding, late buses, and increased on-board security problems (rowdies and drunks). A

sizable number of transit users were exposed to service quality deterioration, and a significant number of prior off-peak users either switched to peak hour buses or discontinued their bus use entirely.

Impacts on Transit Operations

Revenue loss due to the elimination of off-peak fares resulted in a 40 percent reduction in fare revenues. However, due to the relatively small proportion of operating costs covered by general fare revenues, the total financial impact was much less -- about 6 percent of the annual RTD operation budget. The total cost of the one year free fare program was about 4.7 million; $3.9 million in revenue loss, plus about $.8 million in program expenses. About half of the direct project expenditures were the result of extra demands on service and maintenance resources; the remaining half for administration, planning (including data collection for the evaluation) and marketing needs. The total operations budget for Denver RTD during the one year of the demonstration was about $39 million.

Assuming RTD's average operational costs, it may be estimated conservatively that a funding level equivalent to that required to pay for the elimination of off-peak fares, could have provided about 2.8 million additional miles or about 200 thousand additional hours of service during the one year period. On a weekday basis, this is roughly comparable to all day local service on the two regular routes with the highest service levels (15-Colfax and 21-Evans), or the 11 regular routes with the lowest service levels out of RTD's current schedule of 32 regular routes.

Accounting for the fact that the marginal costs of providing new service in Denver is about 80 percent of the average costs of existing service, and that new service would also generate new fare revenues, an even greater amount of new service than indicated above could be supported with funds equivalent to those required to operate existing off-peak transit with no charge to the user. It is clear that gross ridership increases in response to such major service expansions would be substantially less, at least in the short-run, than the 1.7 new bus trips attracted per free fare dollar cost. However, where the trade-off exists, important transit policy objectives such as increased capacity, reliability, and passenger comfort achieved through improved service are probably more compelling than the gross ridership gains and relatively small income transfer effects which may be brought about by operating existing transit free.

Only minor additional service was implemented (about 1% of total) in order to solve the more serious over-loading conditions which were encountered on a few of the high-patronage routes. Consequently, only a minimal cost increase of similar magnitude was caused by the provision of free off-peak transit. However, operational problems occurred considerably more often than before the program and often approached

peak hour levels. Service levels and the on-board environment deteriorated mostly because of increased passenger volumes, but also as a result of more frequent use by rowdy youths and other "undesirable" riders who were perceived as threatening to many RTD users. The lack of available seating, schedule adherence problems, and diminished personal security were the most common complaints of bus riders during the program.

RTD was able to substantially improve most aggregate system performance indicators to the extent that off-peak operations became almost as productive as peak period service. Off-peak passenger boardings per mile of service increased from about 1.6 to 2.4. Peak period service carried about 2.6 passenger boardings per mile during the demonstration. No significant impact on peak hour operations or quality of service, however, were observed.

Increased bus ridership following the free fare demonstration appears to be about 15 percent of the ridership increase experienced during the demonstration due to free fares. The long-term revenue implications are significant but less than may have been expected; it is estimated that between 15 percent and 30 percent of program losses may be recovered within five years.

Impact on General Public

The indirect effects of the free fare program were quite small. The share of total area travel shifted to transit was only about one-half of one percent. The associated effects on eliminated vehicle miles of travel, reduced air pollution and energy conservation objectives were equally small. The impact on CBD retail businesses appears to have been negligible with only a minor increase in downtown shopping trips observed.

The additional tax burden placed on households was also minimal -- only about $2.40 per family unit for the year-long program. But since at least 60 percent of the metropolitan population never used the free transit (or enjoyed any indirect benefits), a problem of inequity may still be indicated. This problem is aggravated by the use of a (regressive) sales tax to support the local share of the program.

The principal indirect impact of the free fare program was on public opinion. Nearly all of the general public were aware of the free transit promotion, with about half willing to support new taxes to continue some type of limited free transit indefinitely. However, public opinion in Denver was even more favorable towards additional taxes to implement service improvements. In general, the free fare program seems to have reinforced the public's positive perceptions of RTD and helped to galvanize support for future transit service innovations.

In conclusion, off-peak free transit does not seem to be a useful long-term transportation policy. However, limited free transit promotions appear to offer an effective means of marketing transit. Implementation of free transit in a more limited application (shorter program, shorter no-fare hours, etc.) may enable the transit operator to totally recover through new ridership increases, all the costs of a free transit marketing effort. With adequate planning, it may also be possible to maintain attractive service levels during a scaled-down free transit promotion which will present public transportation in its best light.

1.0 INTRODUCTION

1.1 History and Objectives of Fare-Free Demonstrations

This section summarizes the recent history and intent of fare subsidies, including the federal legislation authorizing and providing for research into fare free transit projects and the specific objectives of the Denver demonstration.

1.1.1 The Fare-Free Concept

The free fare concept has emerged from the gradual extension of subsidies in public transportation -- first for capital improvements, then operating expenses and more lately, fare discounts. The intent of public subsidy is to bridge the gap between steadily increasing operating costs and declining revenues which most transit agencies confront. Large increases in federal subsidies since the 1960's have served to avoid fare increases in many cities. This has contributed in many cases to the maintenance of modest fares, representing increasingly smaller proportions of total revenues needed to provide transit services. Indeed, farebox revenue now typically covers as little as one-third of operating costs. Yet despite these subsidies and the comparatively recent turn-around in transit ridership in the face of gasoline shortages, many transit operators still face mounting deficits.

The extension of the subsidy concept into free transit supported entirely by funds other than fare revenues has been suggested as a method for solving several transportation problems. Decreasing fares could reduce the perceived cost differential between transit and private auto use, given the greater degree of hidden costs in private vehicle operation.[1] As fares go down, more auto users would be attracted to transit as a competing mode, and overall ridership should increase. In fact, transit properties implementing reduced fare programs typically have reported increases of from zero to 30 percent above pre-reduction ridership levels. Researchers debate, however, whether the price elasticities observed in these cases are applicable to the free fare experience (100 percent reduction) with its total elimination of the fare barrier.[2]

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[1] It has been estimated that highway users pay only about a quarter of the cost of operating the facilities they use. See Richard M. Stanger, "Fare-Free Transit: Do We Really Need a Demonstration Project?" ITE Journal (Nov. 1978).

[2] James I. Scheiner, "The Patronage Effects of Free-Fare Transit," Traffic Quarterly 29 (1975).

In addition to the specific issue of the transit use incentive impacts of free fare transit are a variety of still unanswered questions surrounding the policy implications of public subsidies. Only limited empircal evidence exist to address such questions as: who pays and who benefits; does the extended subsidy serve to reduce operating deficits; and are fare subsidies as cost effective for inducing ridership as service improvements?

Another objective of decreasing fares may be to aid the elderly, those with low incomes and the young by extending them increased mobility to educational, employment and shopping opportunities. The actual impact on mobility and household budgets, however, will determine the degree of equity associated with the free fare policy. An example is the case of low-income riders who make few or no transit trips, but whose taxes help to pay for the subsidy, nonetheless. Accurate determination of the beneficiaries of fare subsidies, in part through comparing the socio-economic characteristics of "new" versus "old" riders, thus provides an important check on this justification for free fares.

Justifying the marginal cost of the additional riders is another question. With more money going to subsidize fares, and with given constraints on non-capital assistance funds, less federal money would be available for service improvements. Yet research findings question whether fare reductions are as effective as service improvements for attracting new ridership generally, or for increasing the mobility of transportation-disadvantaged persons.[3] A 1973 study of fare reduction in Atlanta showed that 80 percent of the gain from dropping fares from 40 cents to 15 cents could have been achieved with a 25 cent fare.[4] Clearly, we need to supplement our understanding of the impacts of free transit subsidies.

1.1.2 Legislative Intent for Free Fare Demonstrations

Since 1974, when free fare transportation demonstrations were authorized under Title 11, Section 201 of the Urban Mass Transportation Act of 1974,[5] the federal subsidies have been accompanied by efforts to increase knowledge about the effects of fare-free transit. Research has included both the direct and indirect effects of free fares on ridership, the mobility of the transit captive, traffic congestion, air pollution, savings in expenditures for auto-support systems, and on fare-free financing alternatives.

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[3] See, for examples, Thomas D. Domencich and Gerald Kraft, Free Transit (Lexington, Man: D.C. health Co., 1970), or Keith M. Goodman & Melinda A. Green, Low-Fare and Fare-Free Transit : Some Recent Applications by U.S. Transit Systems, (Washington, D.C.: The Urban Institute for the Urban Mass Transit Administration, 1977).

[4] Stanger, op. cit.

[5] Additional provisions of the National Mass Transportation Assistance Act of 1974, Title 11, Public Law 93-503 (Washington, D.C., United States Government Printing Office).

Section 6 of the Urban Mass Transportation Act of 1964 carries on this directive by authorizing:

> research, development and demonstration projects... (including... new...techniques and methods)...[to] assist in the reduction of urban transportation needs, the improvement of mass transportation service, or the contribution of such service toward meeting total urban transportation needs at minimum cost.[6]

1.1.3 Objectives of the Denver Demonstration

The Denver free fare demonstration relates directly to two of UMTA's current set of seven major objectives which guide the SMD research of improved urban transportation services.[7]

- Provide more efficient public transportation
- Provide more effective public transportation

Positive impact on the specific project criteria of increased transit vehicle productivity and improved mobility for transit dependent were anticipated with an off-peak free fare experiment. Potential negative effects on other transit operations criteria such travel times and service reliability were also of interest to UMTA/TSC.

In addition, in their grant application to UMTA, RTD identified some specific free fare program objectives:

- Examine the impact of free off-peak fares on transit ridership and automobile travel.
- Maintain and increase public awareness of the transit system through a marketing and public information campaign.
- Determine the cost effectiveness of off-peak reductions.
- Evaluate the impact of the reinstatement of fares on February 1, 1979.

These objectives have provided the basis for developing a set of free fare evaluation issues relevant to both local and national interest in the Denver experiment (see Section 1.4). Findings of the evaluation are intended to provide information about the Denver experience which is relevant to other transit systems across the country.

1.2 The Setting

1.2.1 Geography and Climate

The Denver Metropolitan Area (DMA) is defined in this document as the five-county region of Adams, Arapahoe, Boulder, Denver,

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[6] The Federal Urban Mass Transportation Act of 1964, Public Law 88-365 (Washington, D.C.; USGPO), article 1605.

[7] U.S. DOT, Transportation Systems Center. Service and Methods Demonstration Program Annual Report. Report No. UMTA-MA-06-0049-79-8, August 1979.

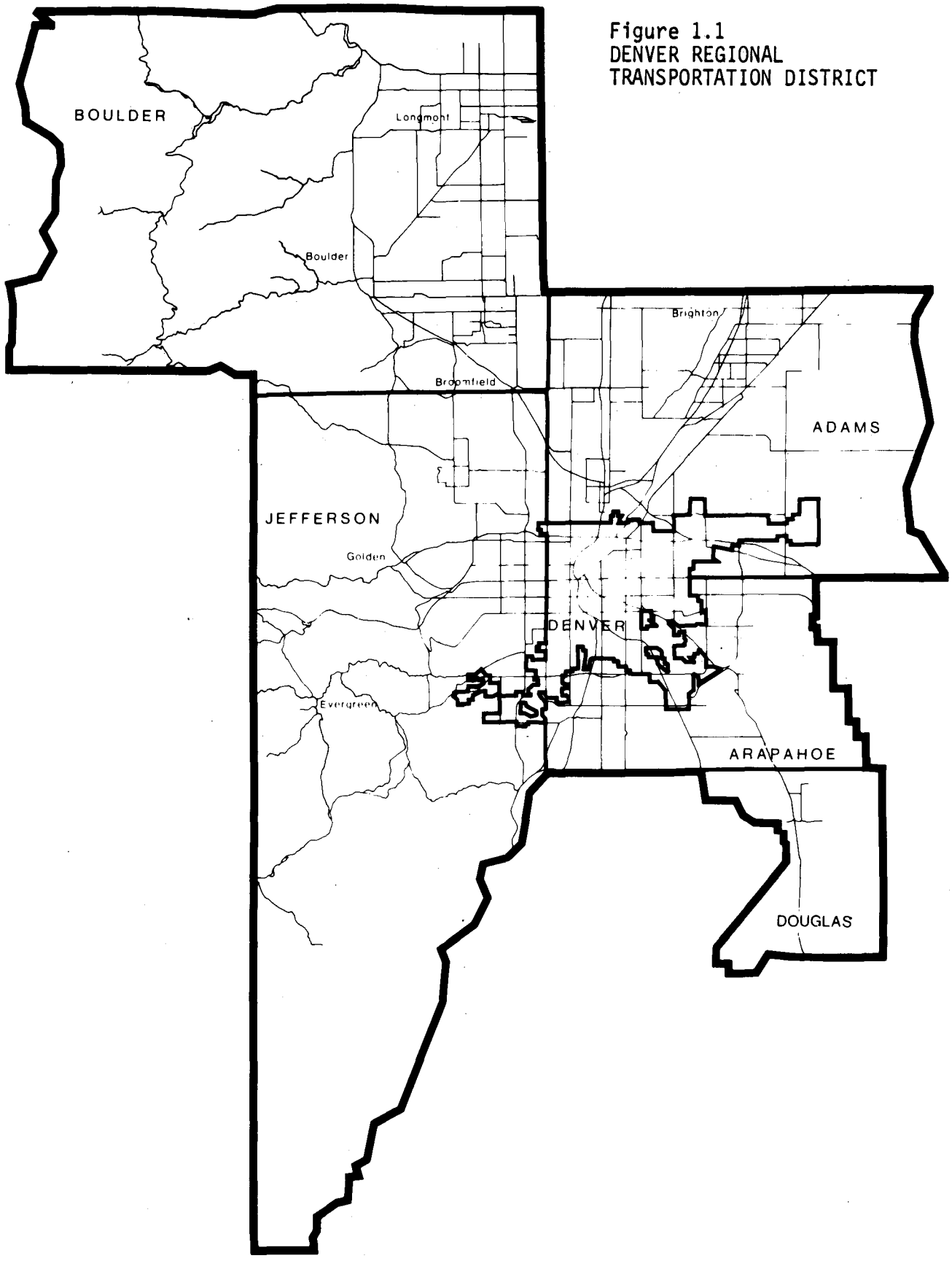

Figure 1.1
DENVER REGIONAL
TRANSPORTATION DISTRICT

and Jefferson Counties. Three additional counties were added to the Denver-Boulder SMSA following the 1970 census. Because of the compatibility between the five-county region and the RTD service area, as well as the availability of adequate demographic data for this area, these three additional counties are not included as part of the DMA definition for the purposes of this report.

The DMA encompasses two major climatic and topographic zones: mountain and plains. Situated in the north-central portion of Colorado along the easterly base of the Rocky Mountains, much of the urbanized area lies along the South Platte River, which runs northeast. A ridge mass extends from the foothills of the Rockies around the southern edge of the metropolitan area and continues northeast. Consequently, the CBD and its surrounding area lies in a basin. Denver has a dry and generally mild climate; the mountains inhibit strong wind movements.

1.2.2 Air Quality

Because of its situation, Denver experiences very low air mixing and frequent temperature inversions, especially in the Fall and Winter. These combined with restricted wind movement, tend to concentrate air pollutants and hold them over the urbanized area, causing periods of acute air pollution often lasting for several days until a major weather change occurs to dissipate the stagnant air mass.

The mix of air pollutants varies by season but pollution remains a year-round problem. In 1974 one Federal study ranked Denver among the six U.S. cities with the most severe carbon monoxide problems, and in the top eleven for high levels of photochemical oxidants.[8] More recently in a study by the National Wildlife Foundation, Denver's air pollution was rated worst in the nation. The winter of 1977-78, when the free fare program was conceived, brought the worst air pollution on record, and the "brown cloud" became a focal point of citizen concern and public agency action.

Several federal, state, and local agencies initiated studies and pilot programs, including carpool information, public vanpools, preferential parking for carpools, non-polluting vehicle races, and staggered working hours to heighten public awareness. These achieved high public visibility. The Colorado State Department of Health also held a series of public forums to solicit comments on alternative strategies to combat mobile-source air pollution. Thus, pollution and its relation to transportation system performance had become a significant legislative, political, and institutional issue. This orientation was a factor in the creation of RTD's free-fare program.

1.2.3 Population and Employment Characteristics

Well over half of Colorado's population lives in the Denver Metropolitan Area, which is the transportation, cultural, educational,

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[8] Horowitz, Joel, and S. Kuhrtz, Transportation Controls to Reduce Automobile Use and Improve Air Quality in Cities, U.S. Environmental Protection Agency, Washington, D.C.; November, 1974.

and political center of the state, as well as the business and financial center of the Rocky Mountain region. Population growth in the DMA has outpaced that in the nation as a whole in recent decades, increasing by over 30 percent per decade since 1960, to 1.59 million in 1978. (This growth is almost 2.5 times the national average.)[9]

While the City of Denver remains the principal activity center for the metropolitan area, in recent years, most of the DMA's population growth has taken place in the surrounding suburban counties. Between 1970 and 1978 the population of the four surrounding counties increased by 47 percent while the population in Denver County (which includes the City of Denver) increased by approximately 2 percent. Denver Metropolitan Area population and employment statistics are summarized in Table 1.1.

With nearly three-fourths of Colorado manufacturing employment, the DMA is the historical manufacturing center of the state. Denver has also become the center of energy resource developing activity in the West and the base of operations for coal, oil, oil shale, and natural gas exploration and development efforts in Colorado, Utah, Wyoming, and Montana. Indeed, the region is the state's employment center, accounting for about 7.3 million jobs, or 60 percent of the Colorado work force. The DMA also includes the state capital, with an estimated one-fourth to one-third of Colorado government jobs located in and around the State Capitol Building in the Denver CBD.

DMA growth in employment has outpaced that of population. While the Denver CBD remains the major employment center, growth in government, trade and service employment -- the fastest growing employment sectors in the region -- has followed trends in population distribution to some extent, with the result that there are now a number of peripheral activity centers complementing the CBD. The Denver Regional Council of Governments (DRCOG) forecasts, however, that the Denver CBD share of areawide employment will increase to 10 percent by the year 2000.

Table 1.1
SUMMARY POPULATION AND EMPLOYMENT STATISTICS, DENVER METROPOLITAN AREA

Year	DMA Population	Annual Growth Rate	DMA Employment	Annual Growth Rate
1960	921,000		387,000	
		2.8%		3.4%
1970	1,229,800		543,000	
		3.9%		4.2%
1975	1,473,800		668,100	
		2.6%		2.7%
1978	1,592,100		723,700	
		3.0%		2.7%
1980	1,690,000		763,200	
		1.7%		2.2%
1985	1,847,700		848,700	
		1.7%		2.2%
1990	2,020,500		944,200	

Source: White, Weld & Co., DRCOG, "Notations."

[9]White, Weld & Co., et al, RTD (Colorado) Sales Tax Revenue Board Series 1977, October 27, 1977.

The distribution of the DMA's major ethnic groups is presented by county in Table 1.2. On the basis of recent population migration patterns, DRCOG projects an overall increase in the areawide proportion of non-whites. While the suburban counties are expected to increase their proportions of these groups, Denver will remain the center of regional non-white population concentrations.

Table 1.2
DMA ETHNIC GROUPS BY COUNTY

County	White	Spanish-Surnamed	Black	Asian-American	American Indian
Adams	80.0%	17.0%	1.3%	1.2%	0.5%
Arapahoe	92.4	4.6	1.7	1.0	0.2
Boulder	91.8	6.3	0.7	0.9	0.3
Denver	61.0	22.7	14.3	1.4	0.6
Jefferson	94.8	3.9	0.3	0.7	0.3
Total DMA	80.6%	12.5%	5.4%	1.1%	0.4%

Source: Colorado Division of Planning, July 1978 Estimates based on 1970 Census, March, 1979, Colorado Business Review.

The age distribution of the regional population is shown in Table 1.3. Approximately 30.6 percent of the population is under 18 years of age. Elderly persons (over 60 years of age) represent about 11 percent of the five county population and this proportion is expected to double by the year 2000.

Table 1.3
DMA POPULATION BY AGE

Age Group	DMA[a]		USA[b]
Under 17 years	28.7%		29.0%
17-24	15.9	46.4	39.8
25-44	30.5		
45-65	17.7		20.1
Over 65 years	8.0		11.0
All ages	100.0		100.0

Sources: a) DRCOG, "Notations." January, 1978
b) U.S. Bureau of Census "Estimates to the Population by States." July, 1978.

The DMA ranks high in per capita personal income compared to other U.S. metropolitan areas. The average DMA household income is also higher than the state average, reflecting the area's concentrations of white-collar, upper income population. Table 1.4 presents this household income distribution for the five-county area.

Table 1.4
INCOME DISTRIBUTION

Income	DMA[a]	Per Capita Personal Income (1975)	
Less than $ 5,000	14.7%	DMA	$6,641
$ 5,000 - 9,999	17.6	USA	$5,903
$10,000 - $14,999	19.1		
$15,000 - $24,999	29.2		
$25,000 and Over	19.4		
Total	100.0%		

Source: a) Bureau of Census, Areawide Housing Survey, 1976.

1.2.4 Regional Travel Characteristics

Perhaps the single most distinctive feature of person travel in the Denver metropolitan area is the dominance of automobiles as the primary mode of trip-making. The area has one of the highest rates of auto ownership per capita of any major metropolitan center in the United States. Only 7 percent of households reportedly do not possess automobiles.[10] Transit ridership in the region accounts for only about 3 percent of all internal trips. Reflecting increasing suburban development, average auto travel distance increased from 5.4 to 5.9 miles between 1971 and 1975. During this same period, vehicle miles of travel per person increased from 12.1 to 13.4 miles.

While traffic conditions have deteriorated substantially compared to those experienced even four or five years ago, congestion is still not an acute problem. The peak travel periods in the morning and evening are relatively short -- 7:00 to 8:00 a.m. and 4:00 to 5:30 p.m. generally -- and congestion dissipates rapidly beyond the peaks. It is estimated that just under 40 percent of all trips to and from the Denver CBD occur during these peak periods.

[10] DRCOG, "A Typical Day of Travel in Denver," February, 1979.

1.2.4.1 The Regional Transportation District

The Denver Regional Transportation District (RTD) was established by the Colorado State Legislature under the Regional Transportation District Act in 1969. Under this Act (Colorado Revised Statutes, 1973, 32-9-010, et seq.) the RTD is empowered to develop, maintain, and operate a mass transportation system for the benefit of the inhabitants of the District. The District covers a 2,284 square mile area consisting of the City and County of Denver, all of Boulder and Jefferson Counties, and portions of Adams, Arapahoe and Douglas Counties (see Figure 1.1). While the District is smaller in size than the DMA, the populations of the two areas are essentially identical.

A twenty-one member Board of Directors governs District operations; representation includes ten members appointed from the City and County of Denver, two each from Adams, Arapahoe, Boulder, and Jefferson Counties, one from Douglas County and two at-large members elected by the other Board members.

The RTD is charged with developing and adopting a comprehensive plan for transit service in the region, in coordination with the land use and highway plans developed respectively by DRCOG and the Colorado Department of Highways (CDH). Local funding sources available to the District include a one-half cent sales tax, with revenues applied to operations, capital improvements and equipment, and debt service. The RTD also has ad valorem tax levying authority of up to two mills on each dollar of assessed property valuation within the District, for deficit payments against operating and maintenance costs, and one-half mill for other expenses except debt service. The sales tax is being collected, but mill levies have not been imposed since 1975.

In 1978, the Board adopted a five-year Transit Development Program which is consistent with the long-range RTD Public Transportation Plan. The new five-year program includes a rapid expansion of the bus fleet, early construction of additional maintenance and storage facilities, and further improvement of RTD's service. These programs can be implemented within the revenues that are currently available to the District and make full use of the Federal financial assistance offered by the Urban Mass Transportation Administration. RTD's share of the capital projects is being financed from the proceeds of a sale of $45,145,000 in sales tax revenue bonds late in 1977. Implementation of the year-long free-fare program necessitated some short-term shifts in TDP element priorities.

1.2.4.2 Transit Service Characteristics

The RTD currently operates bus service throughout the Denver metropolitan region, providing virtually all population and employment centers with a variety of tailored services. The District is divided into the Metropolitan Operating Group (MOG) serving Denver and surrounding suburbs, and the Northern Operating Group (NOG), serving Boulder, Longmont, and intercity routes.

The transit system in effect during the first phase of the free-fare experiment included 44 local routes, 52 express routes, 22 circulator routes and various special services (charter, handicapped, special event shuttles). Within the Denver metropolitan area, the route structure was essentially radial and focused on the CBD, with express routes along major arterial streets and close-in segments of the freeway system. Local service tied express routes together and formed circumferential links around the CBD. The circulators provided collector-distributor service to local and express routes which passed through or connected to suburban activity centers. Within the CBD, where the circulator service was free prior to the free-fare experiment, the primary function was to distribute transit trips to closely spaced stops near major transit trip generators. On September 10, 1978, RTD inaugurated a completely new system of routes and schedules, changing from a radial to a more grid-like pattern. This change and its effects on the free-fare evaluation will be addressed in a later TSC/UMTA evaluation.

The number of bus miles operated has increased steadily from 14.8 million in 1975 to approximately 19.4 million miles in 1977. RTD accepted delivery on 231 new coaches during the early months of 1978. These acquisitions and subsequent retirements increased the fleet to 592 vehicles and reduced the average vehicle age from 8.5 to 3.6 years. Five hundred and five (505) buses are deployed in the Metro Operations Group and 87 in the Northern Operators Group.

Continuing high priority is being given to improvement of maintenance and storage facilities. Four major park-and-ride facilities have been completed; several are in the process of design or construction, and more are programmed for implementation by 1982. Also planned are transfer terminals at high activity areas, improved on-street transfer/stop facilities and joint-use park-and-ride sites where parking is available for shared use by transit riders and others.

1.2.4.3 Fares

Significant restructuring of fares was implemented by RTD in January, 1978 to simplify and rationalize the fare structure and increase the spread between peak and off-peak fares. Fare restructuring emphasized the purchase of monthly passes by regular commuters. According to RTD, these passes provided savings of $3.50 to $15.00 over regular fares, a discount of 24 to 34 percent. Differentiating between regular (pass) and casual (coin fare) costs was intended -- even prior to the off-peak free-fare program -- to induce some casual riders to shift to the off-peak. The 1977, January 1978 and post free-fare 1979 fare schedules are presented in Table 1.5.

1.2.4.4 Transit Use Characteristics

Pre-free fare ridership counts show a steady increase in transit ridership, from 28 million passenger trips in 1975, to 34 million one year prior to free fare in 1977. Transit travel patterns parallel auto travel patterns in that peak period bus capacity is heavily

Table 1.5
DENVER RTD FARE SCHEDULES: 1977, JANUARY 1978, AND 1979 AFTER FREE FARE

Type of Service	1977 Peak	1977 Off-Peak	January, 1978[a] Peak	January, 1978[a] Off-Peak	1977 & 1978 Monthly Pass	1979, After Free-Fare[a] Peak	1979, After Free-Fare[a] Off-Peak	1979, After Free-Fare[a] Monthly Pass
Local								
Regular	$.35	$.25	$ .50	$ .25	$15.00	$ .50	$ .25	$15.00
E&H[b]	.25	.15	.50	.25	12.50	.50	free-.10[c]	12.00
Students	.20	.20	.50	.25	12.50	.50	.25	12.00
Express								
Regular	.50	.50	.75	.75	25.00	.75	-[d]	25.00
E&H	.40	.40	.75	.25	22.50	.75	.25	22.50
Students	.35	.35	.75	.25	22.50	.75		22.50
Circulator								
Regular	.25	.25	.25	.25	7.50	.25	.25	7.50
E&H	.15	.15	.25	.25	5.00	.25	free-.10[c]	5.00
Students	.20	.20	.25	.25	5.00	.25	.25	5.00
Transfer[e]	.05	.05	free	free		free	free	
Intercity								
Medium Distance	-	-	1.00	1.00	32.00	.75-1.00	.75-1.00	35.00
Long Distance	-	-	1.25	1.25	40.00	1.25	1.25	40.00[f]
E&H	-	-	.50	.50	28.00-35.00	1.75-1.25	free-.50[c]	35.00[f]

[a]The off-peak free-fare program began February 1, 1978 and continued through January 31, 1979.

[b]Elderly (over 65 years) and handicapped.

[c]Elderly ride free during off-peak hours; handicapped persons ride at reduced fares.

[d]Express buses do not serve off-peak hours. Should elderly or handicapped persons board an express bus completing a run after the peak period has ended, they receive their off-peak reduction.

[e]Transfers are free since 1978; patrons transferring from a lower to a higher grade of service, however, are required to pay the difference in fares.

[f]Reduced monthly pass rate is also available to students.

utilized, while transit productivity drops off sharply during the off-peak when low load factors are common. As shown in Table 1.6, transit users in Denver differ substantially from the general population. About one-half of weekday bus users are captive riders. RTD riders are generally poorer, younger, and less likely to be white than the general DMA population.

Table 1.6
COMPARATIVE PROFILE OF TRANSIT USER AND GENERAL POPULATION

Percent of Group With:	Average Weekday Bus Rider[a]	General Population[b]
No access to car (older than 17 years)	48%	5%[c]
Income less than $10,000	39%	24%
Non-white	25%	19%
Between 25 and 45 Years of Age	66%	46%

Sources: a) On-Board Survey (5/79)
b) Section 1.2.3
c) Random Household Survey (5/79)

1.3 The Demonstration Project

The Denver free-fare demonstration evolved from the "Transit Awareness Month" promotion initiated and sponsored by RTD during February, 1978. RTD subsequently applied for and obtained UMTA assistance to extend the free-fare program into a year-long demonstration. The following sections describe this evolution, highlighting key features in the organization and implementation of the free-fare program. Detailed discussions of its implementation are found in Section 2.0.

1.3.1 Timing and Organization

The institutional and environmental context in Denver in early 1978 was especially conducive to a transit fare demonstration of the type sponsored by RTD. Air pollution in January had been the worst on record, and public attention was being focussed on transit as an alternative to private vehicle use that could reduce auto emissions and air pollution. At the same time, RTD was accepting delivery on 231 new transit coaches, enabling the retirement of most of the old and unreliable vehicles in the fleet. Moreover, a sale of sales tax revenue bonds at a favorable interest rate had produced an unexpected capital surplus which could be used to fund a promotion coordinated with the arrival of the new buses.

The combination of the opportunity to heighten public awareness of major bus service improvements, local advocacy supporting a response to the air pollution problem, and a desire to acquire hard data on the effects of free-fare worked together in support of the promotion proposal. At their January 26 meeting, the RTD Board of Directors approved a one-month, off-peak free-fare demonstration for February 1978, designated "Transit Awareness Month." The program featured two primary elements. Throughout February, all off-peak transit service in the District was to be free; only peak period service on weekdays between 7:00 - 9:00 a.m. and 4:00 - 6:00 p.m. would continue at regular fares. In addition, Monday, February 6, when the last of the new coaches were to have arrived, was designated "Transit Awareness Day," with service free systemwide all day long.

Transit Awareness Month was conceived and implemented within a relatively short time -- less than two weeks. The need to move expeditiously was further heightened when public and political interest focussed on extending the program. Colorado legislators brought the program to the attention of UMTA officials, and RTD engaged in discussions seeking federal support for a longer demonstration. Rapidly, the support base for continuing the program was consolidated among elected officials, the local business community and the transit agency.

UMTA's interest in sharing the costs to sponsor an extended free-fare demonstration on the scale represented by Denver was secured in an exchange of letters begun late in February between RTD and UMTA administrators. On the eve of its original termination, Transit Awareness Month was extended by the RTD Board, and on March 24, RTD announced its agreement with UMTA to share the costs of continuing the off-peak free-fare program through January 31, 1979. Federal funding would cover approximately half of the cost of continuing the program and would also support collection of data during and after the free-fare period to provide for evaluation of the demonstration's effects. Beginning in July, evaluation of the demonstration was undertaken by TSC and its consultant, De Leuw, Cather & Company. RTD and its data collection contractors were responsible for the development of the data base used in the evaluation.

1.3.2 Implementation and Operation

The mechanics of initiating the off-peak, free-fare program were relatively straightforward: regularly scheduled service was deployed much as usual and drivers were instructed not to collect fares during the off-peak periods. In actual practice, however, there was some confusion among both drivers and riders. Despite extensive publicity, many riders were unaware of the program and required some explanation as to why they should not pay. Most participants had become familiar with the system by the time of the all day free "Transit Awareness Day," February 6, when extra buses and every available driver were put into service to meet the expected -- and realized -- heavy passenger loads.

Continuing the locally-initiated program with federal assistance involved some distinctive implementation and operational features. Promotional marketing for Transit Awareness Month had prepared the public for a limited program. It now became necessary to introduce the year-long demonstration, to marshall awareness of its expended goals, and to implement some necessary changes revealed by the month-long experiment. Briefly, these efforts included eliminating confusion over when to pay, eventually resulting in the use of farebox hoods and the elimination of transfers during off-peak hours; the exclusion of express service from the off-peak free-fare; a change in the morning peak period from 7:00 - 9:00 a.m. to 6:00 - 8:00 a.m.; and reprinted schedules to illustrate the off-peak. The demonstration's focus on staggered work times and transit vehicle productivity in addition to transit use incentive per se were reiterated to justify the off-peak rather than peak period free fare.

1.4 Issues for Evaluation

The effects of the Denver Free-Fare demonstration have implications for transit users, transit suppliers and the general public. The impact issues to be addressed in the free fare evaluation were organized into four subject areas:

- Implementation Process
- Travel Behavior
- Transportation Supply and Cost
- Secondary (or indirect) Effects

1.4.1 Implementation Issues

- Support Base:

  Who comprised the constituency for the free-fare program?

  Who were opposed to the program?

  How has RTD dealt with the internal conflicts arising over free-fare?

- Financial Support:

  How was financing secured to compensate for the loss of short-term operating funds resulting from free fares?

  How do the arrangements agreed upon for Federal support compare with non-demonstration funding alternatives?

- Program Administration:

  What RTD resources were required to support the planning, marketing and managing of the free fare demonstration?

  What were the mechanisms developed to respond to program changes?

- Integration with Other Transit Related Programs:

  How did the free fare program complement or counter other transit-related improvement efforts? Specifically, what were the interactions between free fares and the comprehensive restructuring of routes and schedules undertaken during the year of the demonstration?

  What has been the program's effect on the regional effort to develop effective air pollution and energy conservation strategies?

1.4.2 Travel Behavior Issues

- Aggregate Changes in Ridership:

  How big was the off-peak ridership increase? Was there any effect on peak ridership levels?

  What was the dynamics of ridership growth during the demonstration? How well was new free fare related ridership retained over time after the reinstatement of off-peak fares?

- Changes in Transit Market:

  Who were the new riders due to free fare? How do they differ from former riders?

  Were any riders lost due to free fare? Who were they?

- Changes in Travel Behavior:

  Were increased rates of bus use greater among some groups of former riders than others, e.g., transit dependent compared to more choice riders?

  Were there significant differences between the types of bus trips made at no fare and those that would have been at the normal off-peak reduced fare? Did trip purposes vary?

Did free fare result in measurable shifts in travel out of the peak hours into off-peak period? Shifts from other modes -- ridesharing, automobile or walking?

Did the elimination of the fare barrier result in entirely new trips being made? Were there a significant number of these induced trips representing new mobility for some transit users?

- Changes in Transit User Attitudes:

  Did transit riders approve of the free fare program's implementation? Did they oppose its termination?

  Did the free fare program result in strengthened support for public transit services and taxes?

1.4.3 Transportation Supply and Costs

- Service Reliability:

  How has the increase in off-peak ridership affected the realiability of off-peak service?

- Security:

  What effect have free fares had on the incidence of disturbances and other undesirable behavior on buses?

  How have these changes affected ridership and public support for free fares?

- Transit Operations:

  What effect has the program had on peak and off-peak period fleet requirements and vehicle productivity?

  How has the program affected driver morale and job performance?

- Level of Service Provided:

  How have the free-fare induced ridership changes affected point-to-point transit travel times?

  What were the service quality implications of overcrowding on buses during the off-peak period?

  How have passenger confusion, crowding, vandalism, and other undesirable behavior on buses affected driver courtesy?

- Financial Impacts:

  What were the short- and long-term revenue losses resulting from free fares?

  How were RTD operating costs affected by increased driver and vehicle utilization and public information services? Were increased service or maintenance costs significant?

1.4.4 Indirect Effects

- Retail Trade Effects:

  Have free fares been effective in stimulating retail activity in the Denver CBD?

- Public Support for Free Fare:

  Has the free fare demonstration affected the public's support for, and attitude toward the Denver RTD?

- Changes in Vehicle Mile of Travel (VMT)

  Did the shift of some auto drivers to transit result in measurable reduction in total regional VMT?

- Air Quality Impact:

  Has the free fare program made a significant improvement in the Denver region's air quality?

- Energy Conservation:

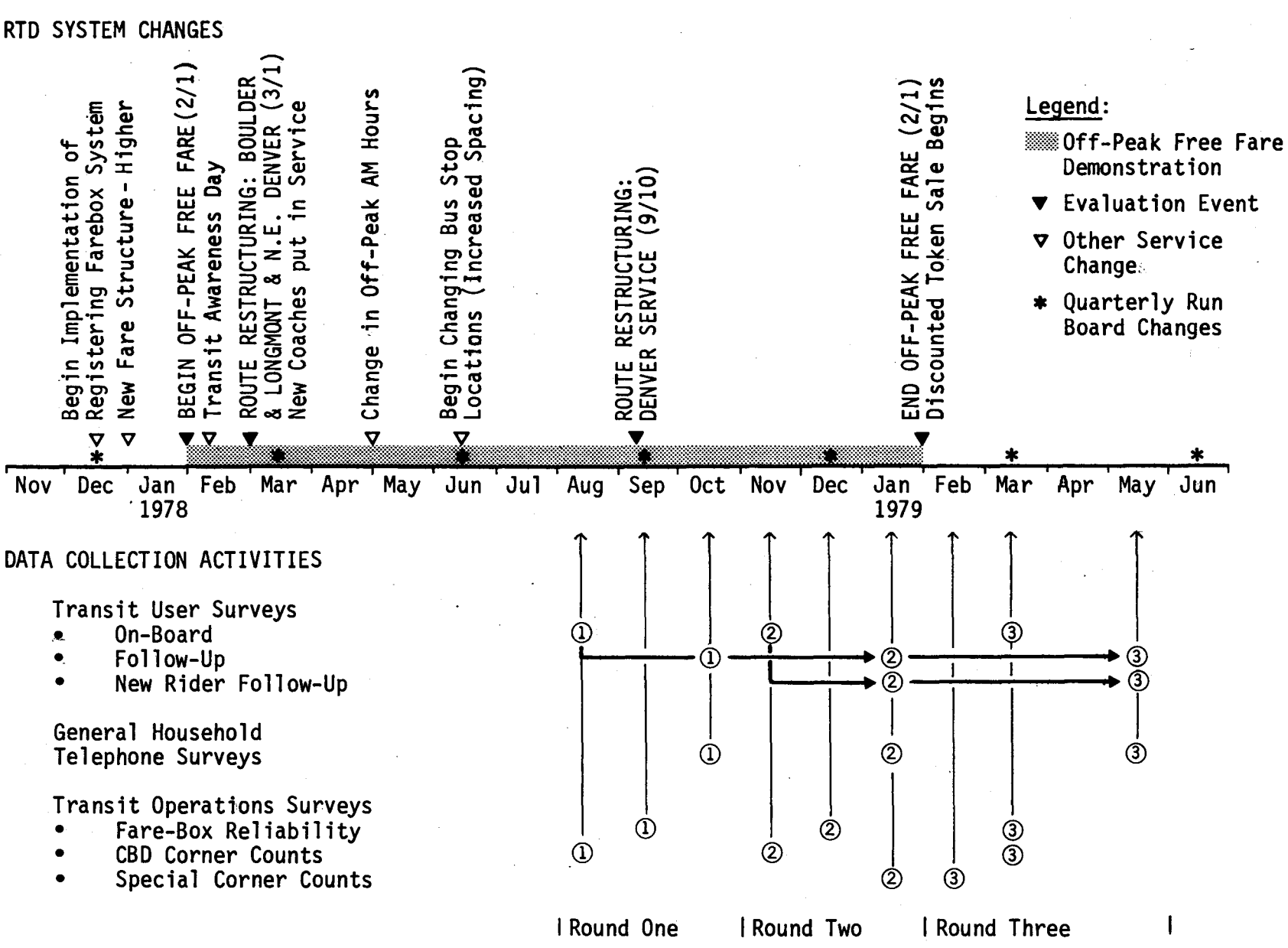
  What was the net energy savings represented by auto trips diverted to transit?

1.5 The Evaluation Process

The essence of the evaluation process consists of comparing travel behavior and system operations prior to, during, and after the free fare demonstration. The analytical framework used is based upon the general philosophy and approach to demonstration evaluation specified by the Transportation Systems Center. The evaluation seeks to document the changes which were made to the transportation system (supply), and to specify what were the travel impacts of those changes (demand). To the extent feasible, the cause-and-effect relationship between the two is identified.

The evaluation methodology was designed in order to control for several factors unique to the Denver demonstration which could affect the validity of free fare findings. The primary factors taken into

Figure 1.2
RELATIONSHIP OF DEMONSTRATION EVENTS AND OTHER TRANSIT SYSTEM CHANGES TO EVALUATION PROJECT DATA COLLECTION



account in the evaluation were major changes in operations, not related to the free fare program, and informational factors related to the quality of data available for the evaluation.

As described in detail in Appendix A, "Data Collection and Reliability," an extensive data collection effort was undertaken as part of the evaluation process.[11] Three rounds of transit user, general household and transit operations data were conducted. Each round of data collection was designed to provide timely information or the effects of both areas of interest in the evaluation - free fare and route restructuring. Figure 1.2 shows the overall relationship of the scheduling of data collection activities with major events occurring before, during and after the demonstration.

1.5.1 Route Restructuring and Other Service Changes

On September 10, 1978, just over seven months into the year-long demonstration, RTD implemented a systemwide route restructuring. In addition, RTD tested its route restructuring plan in March 1978 by implementing partial restructuring on two portions of the system, the Northwest Metro Denver and Boulder service areas. For these areas, the service supply and demand observations collected during the summer will reflect effects of route restructing as well as free fares. Route restructuring also affected systemwide data collection after September, 1978. In order to reduce conflicts between free fare and route restructuring effects, the evaluation employed several different approaches. Before/after comparisons were generally limited to the February through August period prior to systemwide route restructuring. Direct adjustments to the data were also applied as necessary. A follow-up panel of prior and new transit users over three rounds of on-board surveys also provided for pre-, during and post-demonstration longitudinal data.

A number of other system changes occurred during or around the demonstration which have similarly been taken into account:

- RTD's January 1978 fare increases which went into effect just before the free fare experiment began.
- Changes in the RTD bus fleet and bus miles of service.
- Redefinition of RTD's morning peak period from 7-9 a.m. to 6-8 a.m. in early May, 1978.
- Implementation and debugging of RTD recording-farebox patron count procedure in December 1977, with full changeover to the new system in February.

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[11] Data collection activities and a description of the data sets developed in the evaluation are documented in Appendix A. A discussion of the confidence limits of results taken from the analysis of these data is also provided.

1.5.2 Data Limitations

The principal informational factor affecting the evaluation is the lack of extensive and compatable pre-implementation ridership data. As discussed in Appendix B, "Ridership Estimates," pre-free fare passenger count data was adjusted to provide a consistent data base with the during and post-demonstration periods. Given the absence of before transit user profile data, without free fare ridership user characteristics had to be estimated from analysis of survey responses obtained during the demonstration. The January 1978 fare increases precluded extrapolation of pre-demonstration ridership revenues or ridership, so fare elasticities were used to hypothesize ridership without the fare-free demonstration. Post-demonstration data was also applied to extrapolation of the baseline ridership profile. It should be noted that these sources exclude prior transit users whose ridership stopped prior to or early in the demonstration. Standard adjustments to the survey data were necessary, for example, to eliminate over-sampling of transfers and to account for response biases.

2.0 IMPLEMENTATION ISSUES

2.1 Overview of Implementation Process

This section documents the major implementation events in the Denver off-peak free fare demonstration and the institutional setting in which they occurred. Objectives of this element of the evaluation are to identify which implementing procedures worked best, what problems arose and what resources were required to undertake a major free fare transit program of this kind. It should be clear that it is not the aim of this effort to judge the capability or performance of the Denver RTD, but rather to provide "guidance to other locales on possible roadblocks to implementation, steps required to overcome these obstacles, and a representative time period and resource level to allow for accomplishing these steps."[1]

The principal components of the demonstration implementation issues can be related to three variables:

- Time - including lead time to plan for and communicate project events.
- Resources - including both budget and staff time to implement project steps and take advantage of the potential for coordination with related local programs.
- Institutional Mechanisms for achieving effective communication between transit operators and other agencies, transit users, and the general public.

Implementation of the Denver demonstration was generally constrained by limitations imposed on each of these variables. The lead time for planning the initial Transit Awareness Month promotion was extremely short, and subsequent RTD planning of and response to project events was similarly hurried. RTD also undertook an unusually large number of system and operational changes within the overall demonstration time frame, seriously taxing its resources on many fronts simultaneously. Finally and perhaps most importantly, the lack of advance planning for public involvement mechanisms related to the demonstration left the program vulnerable to the vagaries of media influence, hearsay, and the amplifications of its most sensational problems.

The discussion of implementation issue findings in this section is organized around the four main phases of the demonstration - project development, initiation, maintenance, and termination.

2.2 Demonstration Evaluation Participants

The selection, funding, and study of transportation demonstrations was conducted by UMTA's Service and Methods Demonstration (SMD) Program.

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[1] Abkowitz, Heaton, Slavin, 1977.

The Transportation Systems Center (TSC) of the U.S. Department of Transportation was responsible to UMTA for the evaluation of these projects. RTD was the demonstration grant recipient. De Leuw, Cather & Company (DCCO), one of eight evaluation consultants under contract to TSC, was directed to perform the evaluation of the Denver Free Fare Demonstration. The responsibilities of these various participants in the evaluation process may be summarized as follows:

UMTA	Specified evaluation issues of national interest. UMTA is concerned with the transferability to other areas of the knowledge gained through demonstrations.
RTD	Specified evaluation issues of local interest and provided most of the data for evaluation (generally through its data collection contractor, Booz, Allen & Hamilton, Inc.); kept TSC and DCCO informed of demonstration activities.
TSC	Managed the evaluation; coordinated interaction between UMTA/RTD and DCCO; specified evaluation issues of planning and/or methodological interest and provided evaluation guidelines; authorized and monitored all DCCO work.
DCCO	Designed and carried out evaluation; reported to TSC.

In addition, the Transportation Committee of the Metropolitan Planning Organization (MPO) reviewed project proposals and recommendations, advised on demonstration progress, and provided for coordination of the demonstration with other elements of the local transportation planning process.

2.3 Project Development

The Denver free-fare experiment began as a month-long transit promotion initiated and sponsored by RTD. It expanded into a full-scale demonstration project when RTD secured UMTA assistance to extend the program to a full year. The essence of early project coordination and development efforts, both for the month-long promotion and for the federally-assisted demonstration, was their very short lead times.

2.3.1 Initial Coordination

The original promotion was conceived and implemented in approximately two weeks, toward the end of January, 1978. An RTD bond issue at favorable interest rates produced a budget surplus at a time when conditions were especially conducive to a transit-related demonstration. Denver was experiencing some of the worst air pollution on record, and public attention was being focussed on transit as an alternative to private vehicle use that could reduce auto emissions and air pollution. The concept of free bus service was one of several transit use incentive strategies discussed at a mid-January Denver Chamber of

Commerce seminar on growth.[2] The Colorado legislature was also debating the merits of free fare. House Bill 1232, as proposed, required RTD to abolish fares in exchange for an increase from one-half to one cent in its sales tax levy. According to RTD staff, one of the stated objectives of the original promotion was to provide data on the relationship between ridership and fare levels on which the legislature could base its decision.

At the same time, RTD was accepting delivery of 231 new transit coaches, enabling retirement of most of the old and unreliable vehicles in the fleet. The timing was apt for it to introduce a promotion coordinated with the arrival of the new buses, which would respond to the public's concern over air pollution and manifest RTD's interest in transit incentives. RTD had just recently raised its fares systemwide, and a short-term free-fare promotion seemed an appropriate strategy for attracting new ridership.

The combination of the desire to acquire hard data on the effects of free-fares, the opportunity to heighten public awareness of major bus service improvements, and local advocacy for an effective response to the air pollution problem worked together on behalf of the promotion proposal. Support for the program rapidly coalesced among all levels of government, the Denver RTD, the transit workers union, the Denver business community, news media and the general public. In fact, the original idea has been attibuted to several sources, including local business interests and elected officials, as well as RTD. At their January 26 meeting, the RTD Board of Directors approved a one-month, off-peak free-fare promotion for February, 1978, designated "Transit Awareness Month."

The program featured two primary elements. Throughout February, all off-peak transit service in the District was to be free; only peak period service on weekdays between 7:00 - 9:00 a.m. and 4:00 - 6:00 p.m. would continue at regular fares. In addition, Monday, February 6, when the last of the new coaches were to have arrived, was designated "Transit Awareness Day," with service free systemwide all day long.

2.3.2 Financing

The following discussion considers events surrounding RTD's application for federal aid, the federal and local shares of demonstration costs, and the difference in local costs represented by a non-demonstration funding alternative.

2.3.2.1 The Program

The transit operator again had to move very rapidly when public and political interest focussed on extending the free-fare program. Colorado Governor Richard Lamm brought the program to the

[2] Free fare transit for the Denver region had been suggested as early as 1971; RTD Office of Policy Anaysis, "Fare Incentive Demonstration Interim Report," July, 1978, as well as RTD news clippings related to air pollution and the free transit concept.

attention of the Secretary of the U.S. Department of Transportation (DOT) and RTD undertook discussions to pursue federal support for the extension. A six-month program as well as a longer demonstration were originally considered. While discussions proceeded, RTD attempted to continue the current promotion without interruption. But its own funds were inadequate to cover the projected revenue losses of an indefinite extension without federal assistance. Moreover, the RTD Board was reluctant to extend the program even on an interim basis without renewed assurances of UMTA support. The political aspect of the negotiations ensured that the press would keep public attention on the program's developing prospects for federal funding during this interim period. Clearly, the most difficult aspect of the demonstration's early implementation for RTD was undertaking and completing the federal grant application process while maintaining the existing program on a month-by-month basis in hopes of eventual federal approval, given the very short lead time and the extent of interest in the demonstration.

The RTD Board agreed to extend Transit Awareness Month into March on the eve of its original termination at the end of February. An exchange of letters between RTD and UMTA administrators had ascertained UMTA's interest in sharing the costs of an extended demonstration. RTD applied for funding under Sections 5 (Operating) and 6 (Demonstrations) of the basic UMTA Act of 1964.[3] The District's understanding was that final agreement would be reached prior to March 31, and that approval would include reimbursement of the appropriate federal share of program expenses incurred by the District since February. On March 24, RTD announced that it had reached agreement with UMTA to share the costs of continuing the off-peak free fare through January 31, 1979.

2.3.2.2 Public Hearing Requirement

Another early implementation procedure was somewhat complicated by the short lead time and RTD's effort to maintain the existing program while obtaining federal assistance for its extension. Eligibility requirements for funding under Section 5 (but not Section 6) include a public hearing conducted by the designated recipient for consideration of the proposed project's various impacts and its consistency with local planning objectives. This public hearing eventually took place at the end of April, after RTD had already announced its agreement with UMTA and submitted its complete Section 6 application. The hearing also followed directly upon the very controversial one called to gather public comments on RTD's change in the morning peak period. Over fifty people gave individual testimony at this highly publicized gathering; many more submitted letters or statements to be read into the record. In contrast only three persons requested to speak at the formal hearing in satisfaction of Section 5 requirements.[4] Evidently, the earlier proceedings (and on-going free fare activities since February)

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[3] Public Law 88-365, U.S.C. 49, 1604, and 1605.

[4] RTD Board Offical Minutes of April 27, 1978.

had "scooped" the public hearing, or at least suggested to most of the public that the major issues related to approval of the demonstration had already been considered.

2.3.2.3 Federal and Local Shares of Program Costs

Federal funding was obtained to cover up to 50 percent of total estimated program costs; the other 50 percent was supplied through an equal match from local sources (primarily sales tax revenues). UMTA Section 5 funds in the amount of $1.35 million, and Section 6 funds in the amount of $1.0 million were obligated to cover one half of the projected $6.8 million cost of the program.[5]

Although the final accounting had not been completed prior to preparation of this report, RTD indicated that the year-long program actually cost about $4.7 million, including both its revenue losses and other costs. DCCO estimates of RTD revenue losses during the program are comparable with RTD's current estimate of about $3.9 million. Additional operating, marketing and evaluation (data collection) costs due to the free fare program constitute the $.8 million balance of the year-long demonstration's costs.

According to the terms of the 50-50 funding split, RTD will be required to return the unused portions of its grants to UMTA, where the money will remain for reobligation to the transit agency at some future date. At the time of this writing, RTD had submitted project cost statements and received payment vouchers for over $900,000 of its Section 6 award. This information allows us to estimate the final breakdown of the federal and local shares in the demonstration.

Table 2.1
FEDERAL AND LOCAL SHARES OF FREE-FARE PROGRAM COSTS (Millions of Dollars)

Funding Sources	Federal	Local	Total Program
Section 5	1.35	1.35	2.7
Section 6	1.0	1.0	2.0
Total Demonstration	2.35	2.35	4.7

However, the impact of the free fare program on RTD's budget is not entirely captured by the total local share figure of $2.35 million. According to RTD's grants coordinator, the District ordinarily uses Section 5 funding for capital improvements rather than for operating expenses, since the District's 1/2 cent sales tax levy generates more revenue than total operating costs. Section 5 contributions to capital investments, moreover, ordinarily represent 80 percent federal assistance.

[5]Section 5 grants ordinarily cover up to 50% of operating expenses; the contribution from Section 6 may go as high as 100%.

If RTD had received a Section 5 grant of the same magnitude as the free-fare demonstration grant for capital improvements, its own responsibility have amounted to only 20 percent of total costs (about $.64 million). These additional local funds required for demonstration were diverted from the District's capital improvements program for 1978 and resulted in the deferment of some capital improvement expenditures.

2.4 Project Initiation

The first phase of the Denver fare-free demonstration includes initiation of the locally-sponsored program as well as of the federally-funded demonstration.

2.4.1 Marketing

RTD undertook an intensive public information and marketing campaign to present its Transit Awareness Month promotion in coordination with the arrival of the new buses. Activities included bus parades, customer service representatives' appearances at local shopping centers with the new buses, newspaper, radio and on-board advertisement. Some thirty temporary personnel were employed to distribute 30,000 flyers to the public. The service changes also received extensive coverage in the local media. Total costs for pre- Transit Awareness Day publicity amounted to $3500. (No special funds had been allocated for Transit Awareness Month publicity, so these activities were accomplished within the ordinary RTD marketing budget for 1978). Some sixty extra buses and seventy-two drivers were also deployed to provide added service on the all-day free Transit Awareness Day, February 6, 1978.

It was RTD's feeling that this early marketing effort served to familiarize most riders with the fare-free program. Although there was some initial confusion among riders and drivers which was highlighted in the press, most people were familiar with the program by February 6. Since many people saw the program simply as a transit use incentive strategy, however, it was necessary to re-emphasize other project goals going into the extended demonstration. This effort sought to focus public awareness on peak versus off-peak capacity constraints, and to explain RTD's aim to increase off-peak vehicle productivity. In hindsight, RTD spokespersons doubted that their attempts ever really succeeded in communicating the productivity issue. The local papers testify that many people continued to question the usefulness of free off-peak rather than peak period service.

Early skepticism about the program was evident during the first week of February. A few newspaper and radio stations conducted or reported informal "surveys" of transit or automobile ridership on Transit Awareness Day. While the Colorado Department of Highways was said to have observed a slight decrease in vehicular rush hour traffic, the local auto club and downtown garages as well as the reporters themselves maintained that there was no change in ordinary traffic levels.[6]

[6]Examples include the Rocky Mountain News, the Longmont Daily Times-Call, 2-7-78, and KWGN-TV, KLAK, KLZ, Broadcast Information Services, 2/78.

In response, RTD published the results of its own ridership counts and spot checks, showing sizeable increases in transit ridership. It is difficult to say whether these reports of the effects of free fare confused the public or influenced early ridership responses.

2.4.2 Administration

A variety of administrative and service decisions were necessary to implement the original promotion and to continue it into the extended demonstration. The most important pre-program decisions concerned RTD's determination of its peak and off-peak ridership and capacity levels in relation to projected ridership under free-fares; the availability of funds to cover its anticipated short-term revenue losses, and the compatibility of the free-fare program with other local transportation planning goals.

The surplus from the recent January bond issue promised to cover the revenue losses of Transit Awareness Month. Some shift in the priority of items on RTD's five-year Transit Development Program was required to provide the local share of the extended demonstration. This program is updated annually; in any case, the free-fare demonstration induced only short-term postponement and not displacement of capital items. State Congressional action on HB1232 (to abolish RTD fares in favor of an additional half-cent increase in its sales tax levy) was delayed while RTD negotiated federal funding for the demonstration, which temporarily superceded the intent of the bill.

2.4.3 Operations Changes and Training

Early implementation of Transit Awareness Month and its evolution into a year-long free fare demonstration program involved a variety of changes in system operations. Specific actions undertaken during the initial program phases included:

- Development of mechanisms for exchange or refund of monthly passes purchased prior to each tentative conclusion of the original promotion. Uncertainty about the duration of the project in its initial phase required special procedures in both February and March.
- Elimination of transfers during off-peak hours to preclude their use during peak periods.
- Exclusion of all express service from free-fare to avoid confusion over when to pay.
- Provision of hoods to cover the fare boxes during the off-peak.
- Provision of decals explaining the new fare policy, to go on the fare boxes.

- Driver and information operator training programs to explain the free fare program.

- Provision of "tripper" buses to provide extra capacity for particularly crowded routes and times.

RTD mechanisms for receiving and logging customer feedback and complaints had been revised during 1977. Its public information and complaints procedures continued to be improved throughout the free-fare program.

2.5 Project Maintenance and Interim Changes

2.5.1 On-going Marketing

RTD's on-going free-fare marketing and publicity efforts included periodic advertisement in local newspapers, press releases, signs on buses, leaflets and other printed promotional materials. According to RTD staff, these activities were undertaken within the District's ordinary annual marketing budget, and no new staff were added to maintain on-going marketing efforts for the free-fare program. The biggest change in ordinary public information activities was production and dissemination of new schedules showing the off-peak free-fare period as a shaded area to clarify when passengers did not have to pay.

2.5.2 Coordination with the Other Local Programs

Attempts to coordinate the free-fare program with local efforts to achieve widespread staggering of work and commute hours generally fell short of original expectations. Downtown Denver, Inc. (DDI), the Chamber of Commerce, and the regional EPA undertook to survey employee work and travel time preferences in order to supply RTD with data on its potential markets for off-peak commuter services. RTD also continued its on-going procedure of marketing representative contacts with major employers in the area. But the District's cooperation in the staggered work hours program was limited by its staff and budget resources and the needs of its on-going marketing functions. The District urged DDI to pursue a staggered work hours promotion through its membership, and also made a similar proposal to the City and County of Denver. It also began its study of the off-peak travel data provided by DDI and EPA. Implementation of service changes - specifically, new off-peak express runs - was not possible during this time frame, however.

Toward the end of 1978, RTD worked to produce promotional leaflets and posters urging flextime on an individual employee basis. But these materials were not ready for distribution until February, when the free fare program was already over. RTD undertook no more active role in the local flextime effort in conjunction with its free-fare program. In fact, during the latter part of 1978, the transit operator was almost wholly involved in its systemwide route restructuring and associated token and monthly pass promotions.

2.5.3 Program Monitoring

RTD monitored the free fare program through its ordinary mechanisms, such as corner courts and farebox counters. Since drivers were particularly able to observe day-to-day operations, however, their reports provided a good source of free fare monitoring information.[7] The farebox analysis system maintained by RTD provided a source for analysis of selected ridership data (by day of week, route, service type, etc.) to determine the on-going effects of the free fare program. As a result, RTD was able to observe and respond to problems with overcrowding, schedule adherence, and other operational problems which occurred as part of the program. As discussed in Section 4.0, RTD responded with assignment of some extra buses on a few of the particularly crowded routes. In addition to provision of additional service to accommodate especially heavy loadings on some runs, RTD also had to deal with several other major problems affecting on-going implementation of the project.

2.5.3.1 Redefinition of Morning Peak Hours

Early in the program, RTD sought to shift the morning peak hour in order to better represent the actual temporal distribution of travel and to achieve its vehicle productivity objectives. The operator maintained that service was operating near its capacity limits between 6 and 8 a.m., but that there was considerable potential to absorb ridership on the shoulders of this period. Beginning May 1, the peak was officially changed from 7 to 9 a.m. to 6 to 8 a.m. Implementation required immediate refund or purchase of May passes, since 8-9 a.m. travel previously charged would now be free while 6-7 a.m. travel previously free would now be charged.

The change in the morning peak proved controversial and produced strong negative public reaction and opposition. Despite RTD's explanation of the change in terms of its vehicle productivity and revenue considerations, the shift tended to emphasize what many saw as the arbitrariness of free fare. RTD had advocated such a change prior to its receipt of federal funding for extending "Transit Awareness Month." But implementing it during the free fare program was particularly sensitive since the net effect was that more people were being charged for the same trip they had previously made for free.

2.5.3.2 Vandalism and Other Undesirable Behavior on Buses

Public sentiment in opposition to the free fare program crystallized around reported incidents of vandalism, passenger and driver harassment and drunkenness on RTD buses during the off-peak. These episodes received wide news coverage and tended to focus opinion on the negative aspects of the demonstration. It is hard to say whether the coverage itself encouraged the misdoers. The news reports display a

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[7] The transit operator has since obtained a grant to improve its market research and monitoring efforts. This objective of long standing would have been pursued with or without the free-fare demonstration, according to RTD staff.

deliberate and consistent effort not to glamorize such behavior, but to characterize it as childish. RTD responded to the vandalism by organizing school assemblies featuring members of the Denver Broncos football team who encouraged respect for the bus system. The operator also activated a radio system for drivers' use against harassment, as well as to call up relief buses when needed to meet schedules and alleviate crowding. Vandalism rates declined significantly over the summer recess.

2.5.3.3 Organized Opposition to Free Fare

These negative sentiments culminated in organized opposition on two fronts: in June, an RTD Board member from Denver formally recommended abandonment of the program. Lacking a quorum, the Board member agreed to delay action until the July meeting, when 243 RTD drivers (about 30 percent of driver personnel) petitioned to terminate the free fare program. Despite these attempts and RTD's limited ability to respond to them owing to its extensive involvement in planning for route restructuring, there were insufficient votes for the Board to take formal action to reverse its authorization of the demonstration. (Ironically, the drivers presented their petition on the same day UMTA administrator Richard Page presented RTD with its final Section 5 grant to continue the program.) RTD met with drivers' union representatives to agree on compromise measures in response to specific driver grievances. These meetings resulted in some service and run assignment changes in order to respond to driver problems and complaints.

2.6 Project Termination

According to RTD's marketing director, the political context at the time of the free fare program's termination required that RTD adopt a clear position regarding the discontinuance of the free fare policy. There were a few local free fare advocates who wanted the program to continue. There was also some misunderstanding among the public concerning the costs of the program and its funding sources. The majority of transit users, however, appear to have welcomed the return of regular fares and anticipated improved service quality.

Three public postures toward the project termination were open to RTD. The first was a positive approach, thanking the ridership for its support and reporting the project's successful conclusion. The second was an intensive public information effort to explain the project's dependence on the one-year federal grant. The third, and least attractive alternative, was to present the resumption of fares as the abandonment of an unsuccessful experiment. RTD adopted an approach combining elements of its first two options. The District thanked its ridership for their cooperation in the program and reiterated to free fare advocates that the program was intended as a limited experiment which would have to end with its federal funding.

RTD also coordinated the reinstatement of fares with a promotion to market new monthly passes and tokens as a convenient innovation for fare paying. This promotion was greatly assisted by the local grocery stores, which bought the tokens at cost and sold them at 20 percent discount, adding 100 outlets to RTD's distribution plan. The stores also undertook a television advertising campaign which produced an advertising windfall for RTD in addition to its regular newspaper and bus ads and pass-by-mail program. RTD's advance planning for project termination, plus the cooperation of the grocery stores, insured the success of these marketing efforts and certainly contributed to retention of some of the free fare ridership after the program was ended.

3.0 TRAVEL DEMAND IMPACTS

3.1 Impacts of Off-Peak Free Fare on Ridership

Before presenting the findings regarding the ridership impacts of the free fare program it is important to briefly outline the estimation procedures used in this evaluation.

3.1.1 Adjustments to Ridership Data Base

Estimates of ridership impacts of the Denver off-peak free fare demonstration were developed from passenger count and revenue data routinely collected by RTD and summarized monthly by type of transit operation.[1] While providing the only continuous source of bus ridership data available for the before, during and post demonstration periods, these estimates of unlinked transit trips are subject to certain inherent limitations which required special consideration. Based on farebox reliability survey data collected in the project numerous adjustments were made to improve the ridership data base and the estimations of demonstration effects.[2]

These adjustments were intended to account, on the one hand, for pre-free fare period over-counting resulting from a bias in the average fare survey method of passenger count estimation used by RTD prior to January 1978. Passenger counts available from the during and post-free fare period, on the other hand were adjusted to reflect undercounting associated with the implementation and subsequent procedural changes in a driver-actuated registering farebox system. Corrective measures were also employed to estimate average weekly, weekday, Saturday, and Sunday ridership. Information regarding transit trips and user characteristics has been taken from on-board and telephone survey data as well as from aggregate ridership counts available from RTD. Consequently, travel data available to the evaluation was found in a variety of forms which required adjustments to assure compatibility. For example, it has been important to maintain the distinction between boardings (all unlinked trip segments including transfer legs) and person-trips (linked trip segments). The relationship of these transit use indicators in Denver during the off-peak free fare demonstration is shown in Table 3.1.

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[1] Denver, Colorado RTD. "Monthly Progress Reports," January 1976-June 1979.

[2] A discussion of the confidence limits of these data is provided in Appendix A; documentation of ridership estimation methods and data base are presented in Appendix B.

Table 3.1
RELATIONSHIP AMONG UNLINKED AND LINKED TRIPS:
AVERAGE WEEKDAY DURING FREE FARE DEMONSTRATION (February to August 1978)

Type of Passenger Data	Total Weekday	Peak Hours (6-8am; 4-6pm)	Off-Peak Hours (Other)
Unlinked Trips: RTD Counts	155,700 (100.0%)	49,800 (100.0%)	105,900 (100.0%)
Linked Trips: Person Trips	118,400 (76.1%)	40,900 (82.1%)	77,500 (73.2%)

Sources: On-Board Survey (8/78); Appendix B, ridership estimates, DCCO.

3.1.2 Historical Trends and the Estimation of Without Free Fare "Base" Ridership

Off-peak free fare ridership impacts are defined as the difference between observed "actual" ridership during the free fare demonstration and ridership levels estimated to have occurred had off-peak fares not been eliminated - projected "base" ridership. Base ridership projections represent an attempt to isolate all factors which may have affected ridership since the "before" demonstration period other than the implementation of off-peak free fares. These include, service improvements, fare structure changes and secular growth controlling for seasonal variation. The impacts of implementing free fare, the dynamics of ridership during the one year demonstration, and the residual effects following the reinstatement of off-peak fares are examined by comparing these two ridership levels.

During-Demonstration (February-August only)

- Actual 1978 Observed With Free Fare
- Base 1978 Projected Without Free Fare

Post-Demonstration (February-June only)

- Actual 1979 Observed After Free Fare
- Base 1979 Projected Never Free Fare

Analysis of annual transit ridership data reveals a clear relationship of ridership increases with respect to both annual population growth and bus service expansion. A survey of transportation research indicates that estimated service elasticities typically range from 0.3 to 0.7 depending on a number of factors, including city size and level of transit service provided. The assumption of a marginal

increase in ridership of 0.6% for each 1.0% increase in service miles of operation appears to be a reasonable estimate of ridership response to service improvements in Denver. As shown in Table 3.2, a service elasticity of 0.6 explains all but around a 2 percent annual growth in ridership. This may be considered secular growth generally paralleling population growth. The near equivalency of columns C and D in the table tends to confirm the reasonableness of the service elasticity estimate used.[3]

Table 3.2
RIDERSHIP, SERVICE EXPANSION AND POPULATION TRENDS

	Percent Annual Increase			
	A	B	C=A-B	D
Year	Passenger[a] Counts	Service Related Ridership (.6 x change in service miles)	Estimated Secular Growth	Five County Area[b] Population
1976	16.8%	14.6%	2.2%	2.0%
1977	5.6	3.2	2.4	2.7
1978 (Free Fare)	33.7	8.3*	-	2.6

*Average for February to August period: accounts for service increases in March and subsequent reductions in June.

Sources: a) Appendix C
b) Section 1.2.3

These service related and secular growth factors have been incorporated in the estimates of base ridership for both the demonstration (Base 1978) and the post-demonstration period (Base 1979). Based on an estimated annual secular growth rate of 2.3% and an observed increase of about 15 percent in service miles, it is estimated that average weekday passenger counts would have been around 129,500 unlinked trips or about 99,500 person-trips in the pre-route restructuring phase of the demonstration (mean average, February to August, 1978).

3.1.2.1 Effects of January 1978 Fare Increase

Ridership levels for the Without Free Fare hypothesis also reflect estimates of base off-peak ridership given the fare increases which went into effect one month prior to the demonstration (see Appendix B). Since there was not sufficient time to observe the effects of the

[3] Studies indicate that estimated service elasticities in U.S. cities range from +0.3 to +0.8, with urban areas such as Denver where per capita transit useage is low, having generally higher elasticities.

fare increase, it has been necessary to estimate the impact based on assumed price elasticities. The generally established price elasticities of -0.3 for peak ridership and -0.4 for off-peak ridership were applied to estimates of changes in average fare in order to calculate base peak and off-peak ridership. Cross-elasticities were also estimated to account for the effect of increased peak/off-peak fare differentials established in the new fare structure.

Table 3.3
RELATIVE FARE INCREASE: JANUARY 1978

Average Fare (Regular Service)	August 1977	January 1978	Percent Increase
Peak	24.8¢	35.5¢	43.0%
Off-Peak	18.5	19.5	5.4
Average Weekday	21.6¢	27.0¢	25.0%

Sources: August - RTD, Average Fare Survey; January - Estimate based on August passenger distribution with respect to new fare structure.

The estimated effect of the fare increase results in about a 7 percent reduction in Base 1978 ridership or approximately 7,300 average weekday person-trips (or 9,400 unlinked trips), with about 90 percent of these eliminated from the peak hours. Estimated Base ridership reflecting the effects of the fare increase for the 1978 pre-route restructuring period is about 92,200 average weekday person trip (or 120,100 unliked trips).

It is possible that demand for transit in Denver is in fact more inelastic for fare increase of the magnitude implemented than is assumed in this analysis. In fact, a small increase in weekday ridership appears to have occurred in January, 1978 during the first month (and only month prior to the fare elimination) of the new fare structure. To the extent that the estimates of base 1978 ridership may exaggerate the potential depressive effect of higher fares on ridership levels, estimates of the ridership impacts of free fares are similarly inflated. Consequently, the estimates of free fare patronage effects should be viewed as "best case" projections.

3.1.2.2 Effect of Route Restructuring

The second report of the Denver evaluation project will address in detail the ridership impacts of the comprehensive restructuring of transit routes and schedules which went into effect during the off-peak free fare demonstration. The March 1978 changes in Boulder, Longmont, and North-East Denver are reflected in the service related factors affecting base ridership projections for 1978.

An interim estimate of the impact of the changes made in September 1978 has been developed from analysis of the On-Board Survey (11/78) and Transit User Follow-Up Surveys (10/78 and 1/79). The net effect of route restructuring appears to have been around a 3 percent reduction in free fare ridership or a decrease of approximately 3,000 person-trips on an average weekday. This estimate has been applied to the second phase (post route restructuring) of the demonstration base 1978 ridership as well as base 1979 ridership projections.

3.1.3 Impact of Implementing Off-Peak Free Fares

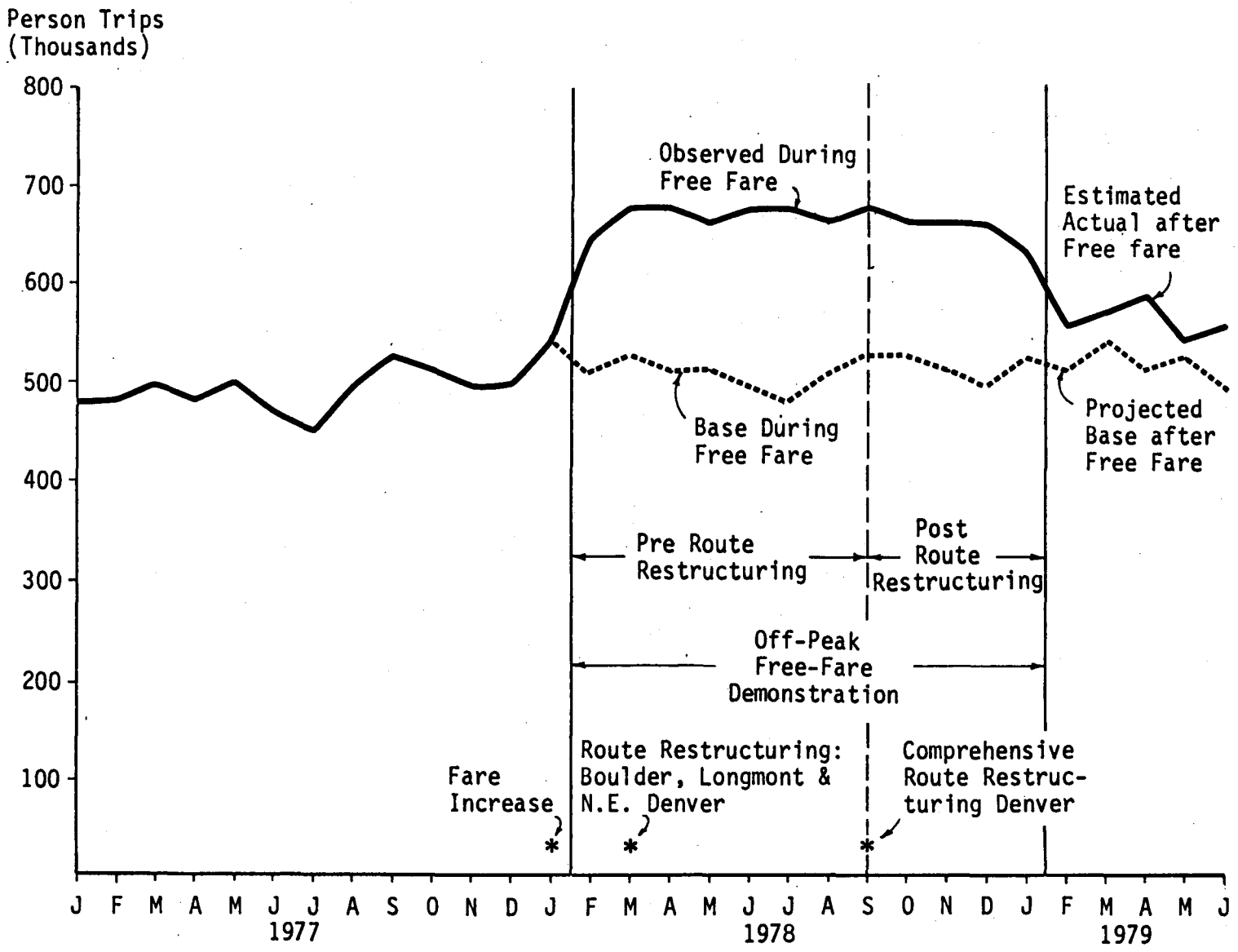
Total ridership on RTD scheduled service during the one year demonstration is estimated to have been 34.3 million bus trips, of which about 8.2 million were trips which would not have been made without the elimination of off-peak weekday and all-day Saturday and Sunday fares. Total bus travel during a typical week, including both peak and off-peak periods, was an estimated 32 percent higher than projected base ridership without free fares. Approximately 70 percent of the 671 thousand bus trips made each week were made during the free hours of service. Off-peak ridership, including the weekend increased by an estimated 52 percent during a typical week (see Appendix B, Table B.7).

Figure 3.1 shows observed weekly ridership levels during the demonstration compared to projected base levels. It should be noted that the projected base weekly ridership reflects estimates of secular growth, the effects of service changes including route restructuring, (September 10, 1972), as well as the effects of the new fare structure adopted one month prior to the demonstration (January 1, 1972).

While the impact on transit ridership was dramatic, the overall effect on transit's share of regional travel was modest. The effect of the demonstration was to increase the portion of the 3.8 million weekday intra-regional trips captured by transit from about 2.4 percent to 3.1 percent of total. However, the impact on travel to and from the downtown was somewhat greater with the buses carrying around 11 percent of all CBD trips during the demonstration. It is estimated that less than 9 percent of CBD trips would have been made by transit without off-peak fare elimination.[4]

[4]DRCOG: "A Typical Day of Travel in Denver," February, 1978.

Figure 3.1
OBSERVED AND BASE RIDERSHIP
Total RTD Weekly Scheduled Service - January 1977 to June 1979



Source: DCCO Ridership Estimates, Appendix B.

3.1.3.1 Ridership Effect by Type of Service

Transit ridership during the demonstration was distributed on RTD scheduled services as shown in Table 3.4.

Table 3.4
DISTRIBUTION OF FREE FARE DEMONSTRATION RIDERSHIP BY TRANSIT SERVICE TYPE (UNLINKED TRIPS)

Regular Denver	80.7
Express Denver	5.3
Circulator Denver	2.0
Metropolitan Operators Group (MOG)	88.0%
Circulator Boulder	7.8
Circulator Longmont	1.1
Intercity	3.1
Northern Operators Group (NOG)	12.0%
Total RTD	100.0%
Year Total: Unlinked	45.3 million
Linked	34.3 million

Source: Ridership Estimates, DCCO, Appendix B.

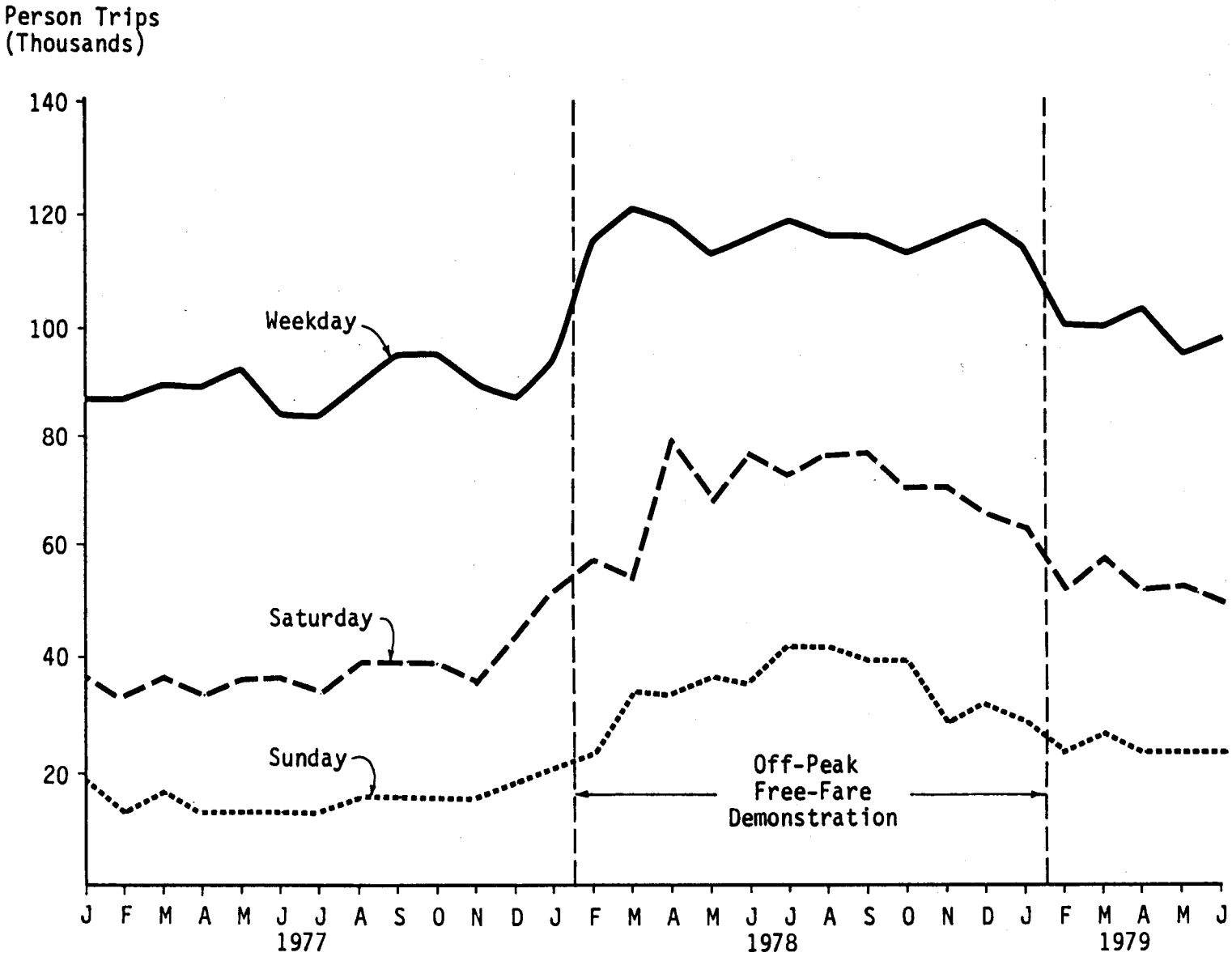
The estimated effect of free fare on Regular route weekday service was a 30 percent increase in ridership levels. The impact on Circulator routes which serve shorter distance trips at a lower fare appears to have been greater than for regular service. After estimating the effect of nearly doubling service in Boulder as of March 1978, the impact of free fares on Circulator service is estimated to be a 38 percent increase over base ridership levels. Ridership levels on the higher-fare Intercity service also appear to have been somewhat greater than on the Regular routes. Once the morning peak hours were redefined in May, such that nearly all Express service fell within the peak hours and consequently required a paid fare, there was no measureable impact on Express ridership levels.[5]

3.1.3.2 Ridership Effect by Day of Week

Figure 3.2 shows the estimated ridership for the average weekday, Saturday and Sunday during each month beginning January 1977. It illustrates a greater increase in weekend ridership over this time frame than occurred for weekday transit trips.

[5]See Section 2.5.3.1 for discussion of the change in morning peak hours.

Figure 3.2
COMPARATIVE RIDERSHIP TRENDS BEFORE, DURING, AND AFTER DEMONSTRATION
Estimated Weekday, Saturday, and Sunday Trips - Total RTD Scheduled Service



Source: DCCO Ridership Estimates, Appendix B.

The aggregate ridership impacts of free fare by day of the week are presented below and summarized in Table 3.5:

- Weekday Ridership

  Average weekday ridership (linked) on all scheduled RTD service was about 119 thousand during the demonstration. This represents an estimated 29 percent increase over projected ridership without off-peak free fares.

- Weekday Off-Peak Ridership

  Nearly all of the 26 thousand additional (net change) weekday linked trips due to free fares occurred during the off-peak hours.[6] Off-peak weekday ridership was approximately 50 percent higher than projected base levels. Off-peak ridership increased from about 52 percent of total weekday in 1977 to 66 percent during the demonstration. This compares to a projected weekday base without free fare off-peak ridership share of 56 percent.

- Weekday Peak Ridership

  Based on estimated peak to off-peak ridership splits, total peak-hour ridership does not appear to have been reduced by off-peak free fares. Despite substantial shifting of travel times by former peak bus trip-makers, peak ridership levels may have been even slightly higher than they would have been without off-peak free fare. Possible reasons for this are discussed in the section on mode choice impacts (Section 3.2).

- Weekend Ridership

  On weekends, service was free all day long. After accounting for the improved weekend service provided during the early phase of the demonstration, the effect of free fares on Saturday and Sunday ridership is estimated at a 50 percent and 93 percent increase, respectively. Saturday's ridership impact was, therefore, apparently equivalent to the impact of free fare on off-peak weekday ridership.

[6] Some prior off-peak users switched to peak bus or stopped making the trip by bus. The net change in off-peak ridership reflects these trip changes as well as the 32 thousand "new" off-peak bus trips made on a typical free fare weekday.

Table 3.5
SUMMARY OF RIDERSHIP IMPACTS: EFFECT OF IMPLEMENTING OFF-PEAK FREE FARE PROGRAM -- TOTAL RTD SCHEDULED SERVICE

	Person Trips (In Thousands)			
	Actual 1978 With Free Fare	Base 1978 Without Free Fare	Estimated Free Fare Impact	
			Number	% Increase
Weekdays	119	93	26	29
o Peak	41	41	-	-
o Off-Peak	78	52	26	50
Saturdays	52	35	17	50
Sunday	27	14	13	93
Total Week	671	510	162	32
o Peak	205	202	3	-
o Off-Peak and Weekends	467	308	159	52

Source: Ridership Estimates, DCCO. See Appendix B.

3.1.3.3 Effect on Size of Transit Market

A major issue surrounding the off-peak free fare program is the effect the demonstration on the transit market. While the number of bus trips increased dramatically, the question remains how large was the population reached by the free fare program? The post free-fare Random Household Survey (5/79), indicates that as many as 39 percent of the population may have used the bus at least once during the one-year program.[7] However, the population of free fare off-peak users in a typical week was considerably smaller - in the range of from 6 to 10 percent.

While no before-demonstration survey data is available, it is possible to estimate the size the transit user population and the average rate of bus use for the demonstration and post-demonstration periods. It must be assumed that the tr

[7] In general, responses obtained in this survey appear, in comparison to the two Random Household Surveys conducted during the demonstration, to substantially oberstate transit use (see Appendix E, Table E.5). About 31 percent of the 5/79 sample stated retrospectively that they typically used no fare transit at least once per week of the demonstration, while only 11 percent of the 8/78 and 1/79 samples (pooled) so indicated during the free fare program. It is possible that considerably less than 39 percent of the population actually took advantage of the free fare program.

periods. It must be assumed that the transit market prior to the free fare program was, like that of the post-free fare transit market, a smaller population of more frequent users than demonstration ridership. As seen in Table 3.6 the effect of free fares apparently was to expand the population of weekly transit users (once per week or more) by somewhat more than 50,000 persons. Based on the random household surveys, it is estimated that 10 percent of the metropolitan population used the bus system during a typical week the year of the demonstration; 7 percent during the off-peak hours. Among free fare users, occasional users represented a large portion of weekly users; about 60 percent made less than five one-way trips per week during the free-fare program. Following the termination of the program, about 70,000 fewer persons used off-peak bus service during a typical week. The 3 percent of the population who remained off-peak users were more frequent bus riders.

Table 3.6
FREE FARE EFFECTS ON POPULATION OF TRANSIT USERS

	Weekly Transit Users (Thousands)			
	During-Demonstration		Post-Demonstration	
	% Sample	Estimated Population	% Sample	Estimated Population
Off-Peak	7[a]	115	3	45[c]
Peak	5[a]	80	5	85[c]
Total Week	10%	160	7%	110[b]
Weekly Trips	-	671	-	567

Sources: a) Random Household Survey (10/78 and 1/79 pooled). See Appendix E; Table E.5.
b) Random Household Survey (5/79). Table E.5
c) Transit Follow-Up Survey (5/79). Table E.6

Due to the timing of the transit user surveys, it is difficult to determine the number of new users introduced to the transit system solely as a result of only the off-peak free fare incentive. Approximately 24 percent of the sample of off-peak weekday bus users surveyed on-board in August, indicated that they did not use the bus prior to the free fare program. Based on ridership attrition and start-up rates observed in the three rounds of surveys, it is estimated that new riders attracted by the demonstration represented between 5 and 10 percent of off-peak weekday riders.

3.1.4 Dynamics of Ridership Growth During Demonstration

The dynamics of free fare ridership provides an indication of the length of time required for a free fare program to achieve its maximum marketing impacts. Figure 3.3 illustrates the estimated trend in new RTD weekly bus trips which can be attributed to the free fare program. The average effect (in the pre-route restructuring phase) was 162,000 additional trips per week, but as shown in the figure, there was considerable variation over-time.

The important factors affecting the growth and stability of free fare ridership appear to have been:

- Start-up Effect: Lagged build-up in ridership due to unfamiliarity with system and personal changes required in travel habits. The special promotional efforts of Transit Awareness Month (February) appear to have accelerated this initial build-up.

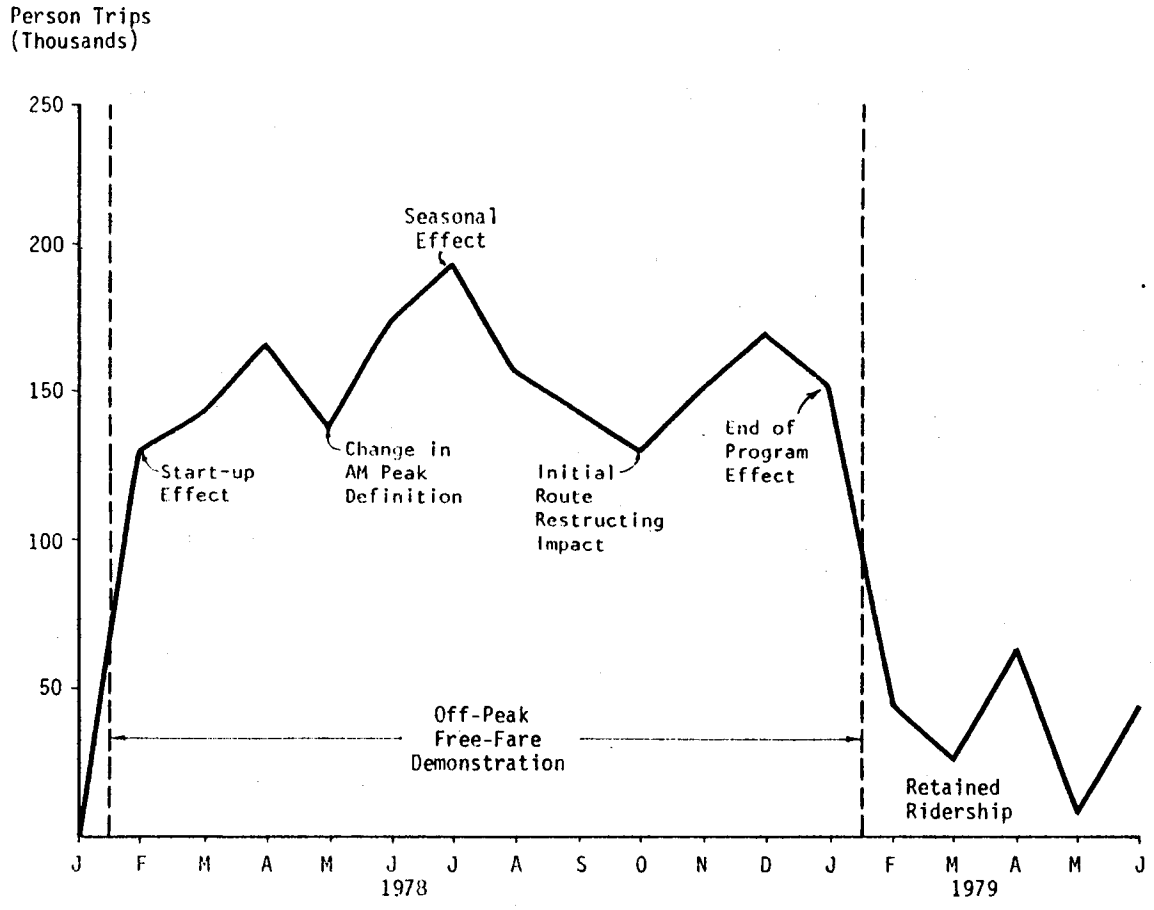
- Change in Definition of AM Peak: Caused some disruption and had a minor, apparently temporary impact on suppressing free fare ridership levels for a short period less than one month.

- Seasonal Effect: A regression model of ridership during the demonstration (see Appendix F) provides strong indication that free fare ridership gains were greatest during the summer months, independent of ridership growth over time. In other words, free fare ridership would have more or less stabilized in the third or fourth month were it not for the seasonal effects of summer. The summer effect can be largely attributed to the transit behavior among youths. In the years prior to 1978, there was a seasonal decline in ridership during the summer. With fewer non-discretionary school-trips made during the summer months, youths would use public transit less often unless there is an incentive to continue using RTD at a high rate. Free fare apparently provided that incentive, with the consequence that seasonal summer variation was moderated and ridership remained more constant.

- Route Restructuring: The free fare ridership growth shown in Figure 3.3 accounts for an estimated average 3 percent reduction in weekly RTD bus ridership as the result of Route Restructuring. The depression in net free-fare ridership gains shown in September and October probably reflects the initial impact of implementing these major service changes.

- End-of-Program Effect: The lower than average response during January may reflect free fare users adjusting their travel behavior in anticipation of the program ending; e.g., establishing ride-sharing arrangements. However, this finding is inconclusive, since severe Winter weather during January may have affected ridership negatively as well.

Figure 3.3
DYNAMICS OF FREE FARE DEMONSTRATION RIDERSHIP - Additional Weekly Trips due to Free-Fare: Total RTD Scheduled Service
(Change over Projected Base)



Source: Ridership Estimates, DCCO, Appendix B

If all of these factors are taken into account, it appears that ridership gains resulting from the implementation of free fare probably would have peaked after about three months of the program. However, it is important to note that the build-up was relatively rapid; about 85 percent of the maximum was achieved in the first month of the program.

3.1.5 Impact of Ending Free Fare Program

As shown in the preceeding graph (Figure 3.3), post-demonstration transit ridership levels were somewhat higher than would have occurred had the free fare program never been conducted. This additional ridership represents revenue generating bus trips which have been retained from the free fare demonstration.

Table 3.7 summarizes the estimated post-demonstration ridership impacts. It shows that average (February to June) weekly ridership was about 38,000 higher than the projected no-free fare base ridership. This represents about an average 23 percent retention of free fare trips, for this five month period. However, as discussed later, this is a "best case" estimate since it ignores strong evidence of other post-demonstration ridership impact factors; in particular, the rapid increase in fuel costs. The table shows that estimated weekend ridership retention was twice that of weekdays. It is also important to note that peak ridership (full fare) may have increased more than expected as a result of reinstating off-peak fares (reduced fare).

Table 3.7
SUMMARY OF RIDERSHIP IMPACTS: ESTIMATES OF POST-FREE FARE RETENTION
(February to June 1979)

	Person Trips (Thousands)			
	Actual 1979 (Post-Free Fare)	Base 1979 (Never Free Fare)	Estimated Free Fare Impact	
			Number	% Retained*
Weekday	101	96	5	19
• Peak	46	42	4	-
• Off-Peak	55	54	1	-
Saturday	41	34	7	39
Sunday	19	13	6	45
Total Week	567	528	38	23
• Peak	232	211	21	-
• Off-Peak and Weekend	334	317	17	-

*Percentage of estimated additional trips attracted by free fare during the demonstration. Average for five month post-demonstration period.

Source: Ridership Estimates, DCCO. See Appendix B.

In order to estimate the long-term ridership effects it is helpful to analyze the decline in residual weekly ridership during the months following the end of the program based on a comparison of observed with projected base ridership.[8] In Table 3.8, the estimated impact, unadjusted for post-free fare external factors, shows that retention was about 30 percent in Feburary, the first month after reestablishing fares. Retained ridership appears to have dropped to about 20 percent in March, but was moderately higher than projected in April. It was again lower in May, indicating a continuing decay in residual former free fare trip-making. June ridership, however does not conform to this declining function.

Table 3.8
POST-FREE FARE AVERAGE WEEKLY RIDERSHIP TRENDS: 1979

	Person Trips (Thousands)			
	Actual 1979 (With Free Fare)	Base 1979 (Never Free Fare)	Estimated Free Fare Impact	
			Number	% Retained*
February	568	522	47	29%
March	571	540	30	19
April	585	521	63	39
May	539	528	11	17
June	555	506	49	30
Average	567	528	38	23%

*Percentage of weekly free fare ridership gain during demonstration--162 thousand. Does not include effect of increased retail gasoline prices (see text).

Source: Ridership Estimate, DCCO. See Appendix B.

It seems quite probable that the two "aberrant" data points of April and June may reflect to a greater degree than the other months the effects of the unprecedented gasoline price increases which occurred in the spring of 1979. While the generally nationwide contraints on fuel supplies apparently were not manifested in the Denver area in terms of the availability of gasoline, rapid increases in retail prices were. Two points are critical regarding the possible effects of these major gas price increases on transit use: 1) gasoline price increases are one of the primary conditions cited by a substantial number of households interviewed (see Section 3.2.3) which would cause them to become regular RTD users, and 2) even a small diversion of area trips to bus would

[8]Estimates of projected "never" free fare base ridership would be increasingly unreliable after June 1979. However, while service miles continued to increase after June, ridership per mile continued to decline in conformance with the trend established in Table 3.8.

result in a fairly large proportional increase in the relatively small number of residual free fare trips accounted for in the analysis. Table 3.9 shows that while the rate of gasoline price increase was high throughout the post-demonstration months, it increased dramatically around April and June.

Table 3.9
RATE OF INCREASE IN AVERAGE RETAIL GASOLINE PRICES: DENVER, COLORADO

	Price	Annual Rate of Increase
January	67.2¢	4%
February	69.2	43
March	71.7	53
April	76.6	120
May	80.5	82
June	86.0	120

Source: Bureau of Labor Statistics. "Energy Index," Table 5.

Based on the February, March, and May observations only, it is estimated that the long-term retention may be as high as about 17 percent of the weekday free fare increases, 24 percent of the Saturday free fare increases, and 30 percent of the Sunday free fare increases. This represents about a 3 percent increase over normal weekly ridership, or about an additional 30,000 bus trips. Weekday, Saturday, and Sunday retention is about 4,000 bus trips each.

3.2 Impact on Individual Travel Behavior

The principal impacts on individual travel behavior expected with the implementation of an off-peak free fare program consist of changes which are directly related to the new price incentive provided for off-peak bus tripmaking. These include increased tripmaking by prior off-peak users, shifting by some peak bus users to the free-fare off-peak, switching to bus from other travel modes, and the inducement of new off-peak bus trips which would not have been made by any mode had off-peak bus fare not been eliminated.

In addition to these direct travel behavior responses to the price change and associated promotion, a number of secondary travel behavior impacts may also be expected. These are basically responses to changes in the quality of bus service resulting from the sizable shifts in passenger loads due to price-induced changes in transit demand. These

would include off-peak trips lost to other modes, discontinued or shifted to peak bus as a result of deterioration of off-peak transit service levels. Similarly peak bus ridership increases could be expected which reflect both temporarily improved service levels as well as a spill-over effect from increased off-peak travel (one leg of round trip).

In total, the direct and secondary travel choice effects constitute a rather complex set of travel behavior actions which reflect the interaction of both price and quality of service changes. The net overall free fare travel behavior choice impact is an equilibrium situation reflecting the evaluation by all potential transit users of the trade-off between the new price and the new service conditions (assuming no other major travel behavior related changes have occurred).

This section focuses on the direct mode choice effects of the Denver free fare program, i.e., off-peak free fare bus trips. These impacts are illustrated in Figure 3.4.

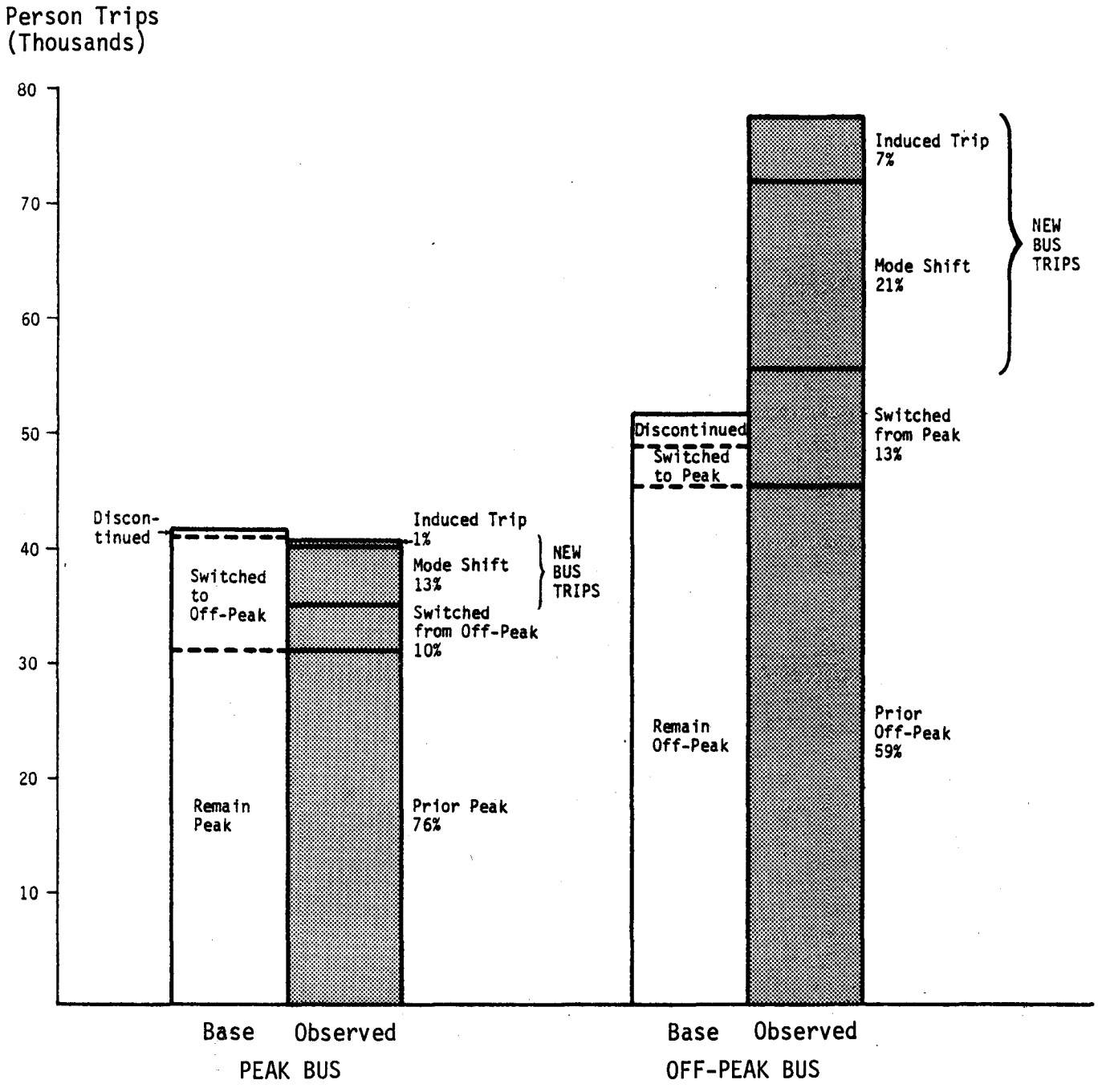
Of particular interest is the extent of apparent secondary impacts on peak bus travel, although substantially smaller than off-peak changes. Also illustrated is the small, but apparently significant, impact on prior (base) off-peak bus users who switched to the peak or reduced the number of off-peak trips made. (Tabular data is provided in Appendix B, Table B.8).

3.2.1 Source of Off-Peak Free Fare Bus Trips

Weekday off-peak free fare ridership during the demonstration came from four general sources of pre-demonstration tripmaking As shown in Table 3.10 about 59 percent of demonstration off-peak bus trips were trips that had been made during the off-peak before free fares; the remaining 41 percent were new off-peak trips. About half of these new off-peak trips (21% of total) were the result of mode shifts, slightly less than a third (13% of total) were former peak bus trips (temporal shifts) and the remaining one-sixth (7% of total) were entirely new trips which were induced by the free fare program.

As shown in Table 3.10, about three-quarters of new bus trips were attracted by free fares from other modes. About half of these mode shifts were trips previously made by automobile; 32 percent as driver, 20 percent as passenger. About 15 percent (3400 weekday bus trips) were reported as formerly made as walk trips. This number almost certainly understates the true percentage of walk trips attracted to free transit. A common complaint of both drivers and passengers was the significant number of passengers who would ride the free bus for only one or two blocks. As discussed elsewhere, it is an inherent limitation of the on-board self-administered survey that these trips would be undersampled.

Figure 3.4
EFFECT OF OFF-PEAK FREE FARE DEMONSTRATION ON TRAVEL BEHAVIOR
Peak and Off-Peak Weekday Person Trips - Total RTD Scheduled Service



Source: DCCO Ridership Estimates; Appendix B, Table B-8.

Table 3.10
SOURCE OF OFF-PEAK FREE FARE DEMONSTRATION BUS TRIPS:
AVERAGE WEEKDAY

Source of Person Trips	Number[a]	Percent[b] All Free Fare	Percent[b] New Off-Peak Bus	Percent[b] New Bus
Former Bus Trips				
• Off-Peak	45,500	59	-	-
• Peak (Temporal Shift)	10,000	13	31	-
	55,500	72%	31%	-
Mode Shift				
• Auto Driver	7,200	9	23	32
• Auto Passenger	4,400	6	14	20
• Walk	3,400	4	11	15
• Other	1,700	2	5	8
	16,500	21%	52%	75%
Induced Trip	5,500	7%	17%	25%
		100%	100%	100%
Total Bus Trips Represented	77,500	77,500	32,000	22,000
% of Total Weekday Bus	-	65%	27%	19%

Sources: a) Ridership Estimates, Appendix B
b) On-Board Survey (8/78)

About 7 percent or 5500 weekday free fare bus trips were trips which would not have been made before by any mode without the elimination of off-peak bus fares. These induced trips represent absolute increases in total travel in the Denver area (all modes).

3.2.2 Effects on Travel Behavior of Prior and New Riders

As discussed previously, the On-Board Survey (8/78) conducted during the demonstration (prior to route restructuring) distinguishes between riders who used RTD before (2/78) and those that began during the free fare program. A limitation on the analysis is the

fact that these "new" riders include a sizeable, but indeterminate number of bus users who represent normal turnover in ridership between February and August 1978 which occurred independently of the free fare incentive.[9] However, the mode choice characteristics of this ridership group do provide some indication of the characteristics of new riders introduced to the bus system due to free fares. Table 3.11 shows the difference in travel choices of those riders who used RTD before the demonstration (prior riders) and those who began since the start of the demonstration (new riders). While about half of the off-peak trips by prior riders would have been made by another mode, almost two-thirds of the new rider trips would have been so made. More than one-quarter of the free fare trips made by new riders were entirely new travel - About 40 percent induced free fare trips were made by new riders.

Table 3.11
NEW OFF-PEAK BUS TRIPS: PRIOR AND NEW RIDERS

Source of Person-Trip	Made by Prior Riders		Made by New Riders	
	Number	Percent	Number	Percent
Temporal Shift (Peak Bus)	9,000	38%	1,000	12%
Modal Shift	11,600	49	5,100	62
• Auto Driver	4,700	20	2,500	30
• Auto Passenger	3,300	14	1,000	12
• Walk	2,600	11	800	10
• Other	900	4	800	10
Induced Trip	3,200	13	2,200	26
Number of New Off-Peak Trips	23,700	100%	8,300	100%
Percent Represented	(74%)		(26%)	

Sources: On-Board Survey (8/79); User Follow-Up (10/78); Ridership Estimate DCCO, Appendix B.

New riders as a group were fairly similar to the total weekday free fare ridership, the primary difference being a smaller percentage of trips made by the elderly. Only 3 percent of weekday trips made by new riders were made by those 65 years of age or older as

[9] See discussion of transit market, Section 3.1.3.3; and On-Board Survey 1 (8/78) in Appendix A.

compared to 10 percent of trips made by pre-demonstration RTD users. New riders were slightly less likely than former riders to think that free fares had negative effects on the service quality of RTD operations. The average off-peak bus use frequency for new transit user was about 2.3 trips per week; about 2.6 trips per week for prior users. This indicates that the population of new riders was larger than their proportion of bus trips on a given weekday.

3.2.3 Travelers Not Affected by Free Fares

Of course, only a small percentage of total weekday travel in Denver was affected by the free fare program - about one-half of one percent of internal trips (all modes). At least 60 percent of the population never used free transit at all during the demonstration. The reasons why most travel was not affected by the free fare program appear to be much the same as those factors which explain why the majority of the Denver metropolitan area population did not use transit before the program. These were almost exclusively related to preference for auto travel and the perception of inadequate bus service levels to meet their travel needs.

Table 3.12
REASONS FOR NOT USING FREE FARE BUS

Reason	Percent*
Suitability of Automobile	42%
Prefer Auto	23
Driving More Convenient	8
Need Car for Work	8
Carpool	3
Difficulties With RTD Service Levels	45%
Bus Stop Too Far	29
Travel Time Too Long	11
Confusing Schedule	5
Bus Not Free During Peak Hours	10%
No Transportation Need for Buses	18%
Other	7

*Multiple responses, do not sum to 100%.

Source: Random Household Survey (5/79)

About 4 percent of all households indicated that at least some members of the family were regular RTD users; almost half (46%) considered their household potential transit users. Table 3.13 shows the stated circumstances which would cause these households to become regular RTD users. Improved bus service which would compete more favorably with the convenience of the auto is the principal prerequisite for a mode shift to transit for this group. Only a very small percentage indicate that free fare would cause them to change their travel habits on a regular basis. Interestingly, the effects of gas price increases or fuel supply constraints apparently constitutes a substantially more important factor in the choice between transit and auto, than the price of transit per se (see Section 3.1.3).

Table 3.13
CIRCUMSTANCES UNDER WHICH POTENTIAL USERS WOULD BECOME REGULAR BUS RIDERS

Circumstance	Percent*
Gas Price Increase	21%
Gas Rationing Shortage	17
Bus Service Improved	46
No Fare	2
Other Reasons	40

*Multiple Responses, do not sum to 100%

Source: Random Household (5/79).

There are other indications that fare may be less important in the mode choice decisions of potential transit users than service levels. Most people, regardless of their rate of bus use, perceive transit to be cheaper than auto for the trip to work. An analysis of perceived auto/transit travel costs differences among regular workers (travel to work five days per week) shows that most of these persons think that even with normal fares, transit is a substantially cheaper mode than auto for their trip to and from work. The average perceived daily savings with transit was in fact slightly higher by those who saw themselves as potential bus users ($1.63/day) than current regular users ($1.60/day). On the other hand, the group which predicted they would never be regular bus users, did not perceive as great a travel cost savings ($1.13/day) as either regular or potential transit users.

3.2.4 Travel Behavior After the Demonstration

Of the total weekday post-demonstration ridership, about 71 percent indicate that the frequency of their bus travel did not change with the end of the free fare program. However, 17 percent indicate that they make fewer bus trips than during the program; 6 percent now

make more. There was apparently also substantial shifting of travel times by RTD riders following the fare reinstatement. As shown in Table 3.14, while there was a net shift from off-peak to peak reflecting the change in price, there was also a sizeable number of peak bus trips made during the demonstration which shifted to the off-peak after the demonstration, presumably in response to perceived improvements in service quality since off-peak bus travel was no longer free.

Table 3.14
CHANGE IN WEEKDAY BUS TRIPS DUE TO END OF OFF-PEAK FREE FARES

Source of Post Demonstration Bus Trips	Peak	Off-Peak	Weekday Total
No change	72%	81%	77,600
Off-Peak to Peak	19	-	9,000
Peak to Off-Peak	-	12	6,300
New Trip: Not Made During Demonstration	9	8	8,200
	100%	100%	-
Trips Represented	46,400	54,800	101,100
% Represented	(46%)	(54%)	(100%)

Source: On-Board Survey (3/79)

3.3 Changes in User Characteristics

Changes in the socio-economic composition of transit ridership might be expected with expansion of transit's share of the travel market as a result of the fare elimination and program promotions. To the extent the program reached a new travel market of less captive transit users, a shift toward a more affluent, more white and younger (adult) user population would be observed. On the other hand, free fare transit service has been suggested as a method of improving the mobility of transporting disadvantaged people, increasing their opportunities for employment, shopping, recreation and education. New trips which have been induced by free fare represent additional travel and increased mobility; trips diverted from other modes may also indicate improved mobility, to the extent that the free service increased the riders' freedom to choose when and where to travel.

3.3.1 Effect on Off-Peak Ridership During the Demonstration

The differences between the socio-economic profiles of RTD weekday off-peak ridership before and during the free fare demonstration are the result of differences in the rate of increase in off-peak tripmaking among different groups of users in response to the free fare program. Table 3.15 shows that while off-peak weekday bus trips increased about 50 percent due to free fares, there was some variation in the rate of increase among various socio-economic categories of weekday bus users. In general, differences in off-peak bus use growth were fairly small, the exception being a considerably lower rate of off-peak use increase among persons 45 years and older than among younger transit users. Stratification by income shows a moderately higher growth rate among the more affluent weekday bus users than those with lower incomes. Less of a difference can be measured between racial groups; however, the growth in off-peak bus trips is slightly higher among non-whites than for whites.

As shown in Table 3.16 the result of the generally small differences in response rates to the free fare program among different socio-economic groups was only slight overall changes in the composition of off-peak transit ridership. The aggregate profile of weekday off-peak bus riders during the demonstration, as compared to the profile prior to demonstration, was a somewhate younger population with slightly higher incomes, with a smaller share of trips made by whites. However, differences between off-peak bus tripmakers and peak bus tripmakers remained much larger than those between before and during demonstration off-peak weekday ridership groups.

Table 3.15
INCREASE IN WEEKDAY OFF-PEAK BUS TRIPMAKING
BY SOCIO-ECONOMIC GROUPS

	Base[a] Off-Peak Bus	Observed Off-Peak Bus	Percent Growth
Household Income			
Under $5,000	13,500	20,400	51%
$5,000-9,999	14,000	19,600	40
$10,000-14,999	9,500	14,400	52
$15,000-24,999	8,800	13,700	56
$25,000 & Higher	5,700	9,400	65
	51,500	77,500	50%
Age			
1-16	9,200	14,700	60%
17-24	14,900	23,200	56
25-44	14,700	22,800	55
45-64	8,100	10,900	35
65+	4,600	6,000	30
	51,500	77,500	50 50%
Race			
White	34,100	50,400	48%
Black	8,400	12,800	52
Hispanic	6,400	10,100	58
Other	2,700	4,300	59
	51,500	77,500	50%

[a]The distribution of base (without) free fare off-peak trips has been estimated from the distribution of On-Board Survey (8/78) responses of prior off-peak bus tripmakers.

Source: On-Board Survey (8/78); DCCO Ridership Estimates, Appendix E.

Table 3.16
PROFILE OF WEEKDAY BUS TRIPMAKERS BY SOURCE OF FREE FARE BUS TRIP

Household Income Group	Weekday Bus Trips During Demonstration: Off-Peak: Former Off-Peak Bus	Former Peak Bus	Mode Shift	Induced Trip	Total Off-Peak	Total Peak
Less than $5,000	26%	36%	23%	24%	26%	11%
$5,000-9,999	27	24	23	24	25	22
$10,000-14,999	19	17	17	18	19	21
$15,000-24,999	17	14	20	21	18	25
$25,000 & Higher	11	9	17	12	12	21
Percent of Weekday Bus Trips	100%	100%	100%	100%	100%	100%
Age Groups						
Less than 17	17%	24%	22%	20%	19%	4%
17 to 24	28	29	32	40	30	27
25 to 44	29	27	33	29	29	45
45 to 64	17	11	11	8	14	22
65 & Older	10	10	3	3	8	2
Percent of Weekday Bus Trips	100%	100%	100%	100%	100%	100%
Racial Groups						
White	67%	56%	65%	65%	65%	75%
Black	16	20	16	15	17	12
Hispanic	12	18	12	13	13	9
Other	5	6	6	7	6	4
Percent of Weekday Bus Trips	100%	100%	100%	100%	100%	100%

Source: On Board Survey (8/78); DCCO Ridership Estimates, Appendix E.

3.3.1.1 Income Groups

Growth in off-peak transit travel as a result of the demonstration varied directly with income. In general, the more affluent the group of transit users, the higher the growth rate of off-peak bus trips. While the rate among the two groups at the lower end of the income scale (less than $10,000) was about a 46 percent increase, the rate was a 60 percent increase for the group at the upper end of the scale ($25,000 or higher). Because of free fare, the income profile of off-peak ridership shifted upward as higher income transit users made a larger share of free fare bus trips. Without free fare, those from a household with an annual income of $15,000 or more would have made 28 percent of the off-peak trips, but with free fare they made 30 percent of off-peak bus trips. On the other hand, those from low income households (less than $10,000) exhibited a small decrease in their share of off-peak trips, from 53 percent to 51 percent. Bus despite this minor shift, those from the lower end of the economic scale (under $10,000) still made a majority of the off-peak trips.

The small overall shift in the income profile of weekday off-peak ridership resulted from a higher share of more affluent free fare users diverted from other modes of travel, predominantly the automobile. While those with incomes of $25,000 or more made about 12 percent of weekday per fare trips, 17 percent of those trips shifted to free transit from other modes were previously made by this upper income group. Conversely about 60 percent of weekday free fare trips previously made by bus during the peak hours were made by riders in the lower income groups. These low-income users made about 45 percent of trips which were previously made by other modes, and about 51 percent of total weekday free fare trips.

3.3.1.2 Age Groups

A more substantial shift in the age profile of off-peak transit tripmakers resulted from systematic differences in trip growth rates by age. Growth rates for off-peak transit travel varied inversely with age, ranging from a 60 percent increase for youths (16 and under) to a 30 percent increase for the elderly. Those under 25 years of age increased their share of weekday off-peak transit trips from 45 percent of 49 percent of total as a result of the free fare program.

Youths showed the highest rate of peak-to-off-peak bus shifting. Similarly, the rate of mode shifting due to free fares was the highest among the younger age groups (under 45 years) than was their share of total free fare trips -- 87 percent of former non-transit mode trips compared to 78 percent of total off-peak demonstration trips. Consequently, the demonstration shifted the age profile of

off-peak ridership downward as the older users made a smaller share of off-peak bus trips. Prior to the demonstration, those 45 and older made about 27 percent of off-peak weekday trips, but with free fare they made only 22 percent. All of younger age groups increased their share slightly by one or two percentage points.

3.3.1.3 Racial Groups

Differing levels of response to the free fare program by persons of different ethnic groups are apparent in the analysis of growth rates. Whites exhibited the lowest growth rate in off-peak transit travel. Off-peak trips made by whites increased by about 48 percent, while off-peak trips taken by non-whites increased by about 57 percent. However, the free fare demonstration had only a small impact on the aggregate racial profile of off-peak ridership. By far, whites continued to make the largest share of off-peak bus trips, despite the fact that whites represented a somewhat smaller percentage of the off-peak trips during free fare (65%) than their percentage of former off-peak trips (67%) trips.

The only evident variation by ethnic category in the source of free fare transit trips is among free fare bus trips previously made by bus during the peak hours. Non-whites showed a higher rate of temporal shifting (44% of former peak bus trips) than of free fare tripmaking in general (35% of total weekday off-peak tripmaking).

3.3.2 Effect on Off-Peak Ridership After the Demonstration

The socio-economic profile of post-demonstration off-peak ridership is significantly different from what it was during the late summer months of the free fare demonstration in Denver. This appears to be the result of both seasonal variation in weekday transit ridership, as well as varying rates of retention among different socio-economic groups. Since the free fare On-Board Survey (8/78) was conducted during the summer, and the post-free fare On-Board Survey (3/79) was done in early spring, seasonal variation may account for much of the observed differences. The effect of summer weather, school recess and vacation schedules on bus travel may be significant with respect to the age distribution of bus users in particular. Despite this limitation; there is a fairly good indication as shown in Table 3.17 that post-demonstration off-peak ridership has shifted toward a slightly younger, more white, and higher income user population.

Table 3.17
EFFECT ON THE SOCIO-ECONOMIC CHARACTERISTIC OF OFF-PEAK WEEKDAY TRIPMAKERS

	August 1978 Projected W/O Free Fare	August 1978 With Free Fare	March 1979 Post-Free Fare
Median Age	27.3	25.7	25.8
Median Household Income	$9,400	$9,700	$10,400[a]
Percent White	66%	65%	70%

[a]Adjusted to 1978 dollars, assuming a 13 percent annual rate of inflation.

Source: On-board surveys (8/78 and 3/79), DCCO estimates.

Another way of estimating the residual effect on the socio-economic characteristics of post-demonstration ridership is to compare the relative response rates of different groups to both the implementation and termination of the program. Using reports of current and previous tripmaking in the August and the March on-board surveys it is possible to assess the direction and relative magnitude of the net short-term effect of RTD ridership profile. Table 3.18 shows that based on this analysis, off-peak transit ridership in Denver consists of a somewhat more affluent and more white distribution of bus users that it would have been without the free fare program.

3.3.3 Socio-Economic Variation in Weekly Free Fare Trip Frequencies and Usage Rates

Overall, 115,000 persons made 467,000 one-way free fare bus trips during a typical week during the demonstration (Random Household Survey, 10/78 and 1/79; see Appendix E, Table E.5). This suggests that the average number of free fare trips made each week was about four bus trips per free fare user. However, an alternative, and perhaps more reliable estimate of weekly free fare frequency is derived from analysis of the Transit User Follow-up Survey of weekday free fare users identified in the August 1978 On-Board Survey. The responses of transit users in this survey indicate that average weekly free fare use was about 2.5 off-peak trips per free fare user -- or about 190,000 total weekly free fare users.[10]

[10]The trip frequency distribution reported by free fare users in the follow-up survey has been adjusted to account for selection probability bias, which results from more frequent users selected from the on-board survey of weekday trips making up a larger share of the follow-up panel than their actual proportion of weekly transit users.

Table 3.18
RESPONSES IN OFF-PEAK RIDERSHIP BY SOCIO-ECONOMIC GROUPS: IMPLEMENTATION AND TERMINATION

Socio-Economic Group	Increase in New Trips Due to Eliminating Fares	Decrease in Off-Peak Trips Due to Reinstatement of Fares	Net Change in Share of Off-Peak Ridership
Age			
1-24	Higher than average	Higher than average	Indeterminate
25 & Older	Lower than average	Lower than average	Indeterminate
Household Income			
$ Less than $10K	Lower than average	Higher than average	Small decrease
$10K & more	Higher than average	Lower than average	Small increase
Race			
White	About average	Lower than average	Small increase
Non-white	About average	Higher than average	Small increase

Source: On-Board Surveys (8/78 and 3/79).

As shown in Table 3.19, there was considerable variation in average trip frequencies among different socio-economic groups. The table shows the percentage of weekly bus users (Column C) represented by each group as estimated from the relation between the average weekly frequency (Column A) of each group and that group's share of weekday free fare bus trips (Column B). Comparison of a group's share of weekly ridership population with its proportion of total regional population (Column D) yields an estimate of the percentage of that population subgroup which used free transit in a typical week during the demonstration (Column E).

3.3.3.1 Income Groups

Trip frequencies among income groups show slightly higher than average rates among those in the highest income group ($25,000 or higher) and those in the lower income category ($5,000 to $9,000). However, a direct inverse relation is shown for income with respect to percent of population using free fare in a given week. As many as 31 percent of those with incomes less than $5,000 used free transit at least once a week while only 3 percent of those with incomes of $25,000 or more did so.

Table 3.19
WEEKLY OFF-PEAK RIDERSHIP RATES

	A Average Weekly Frequency	B Weekday Bus Trips	C Weekly Users	D General Population	E Users as Percent of Population Subgroup
Income:					
Less than $5K	2.3	27%	29%	9%	31%
$ 5K - 9,999	3.0	25	21	15	13
$10K - 14,999	2.5	19	19	19	9
$15K - 24,999	2.0	17	21	33	6
$25K & higher	3.0	12	10	27	3
Age:					
1-16	1.6	19%	29%	29%	9%
17-24	2.6	30	28	15	18
25-44	2.8	29	25	30	8
45-64	3.1	14	11	18	6
65 & over	3.5	8	6	8	7
Race:					
White	2.7	64%	60%	81%	7%
Black	2.2	17	19	5	36
Hispanic	1.8	13	18	12	14
Other	5.1	6	3	2	20
Total (Average)	2.5	100%	100%	100%	9%

Sources:
A. Transit User Follow-Up Survey (10/78); Responses weighted to correct for probability of selection bias.
B. On-Board Survey (8/78).
C. Computed from Column A and Column B:

$$1/a_i \times 2.5 \text{ average trips per week} \times b_i = c_i$$

D. Population estimate. DRCOG "Notations."
E. Computed from Column C and Column D: $(c_i \times 150{,}000 \text{ weekly users})/(d_i \times 1{,}590{,}000 \text{ population} = e_i)$. Estimates of weekly free fare users range from 115,000 to 190,000 for typical week during demonstration.

3.3.3.2 Age Groups

The clearest pattern revealed in Table 3.19 is that the free fare trip frequency rate varied inversely with age -- a larger population of younger users making off-peak trips less often each. About 18 percent of the population of young adults (17 to 24 years) may have used free transit each week as compared to about 6 to 9 percent of all other age groups.

3.3.3.3 Racial Groups

White free fare users were a relatively smaller sub-group of somewhat more frequent transit users than either of the two major minority sub-populations -- blacks or Hispanics. While only about 7 percent of the white population used free fare during a typical week, as many as 36 percent of the black population and 14 percent of the Hispanic population took advantage of free off-peak transit service.

3.3.4 Impact on the Transportation Disadvantaged

Two issues are of interest with respect to the effects of the free fare program on the transportation disadvantaged. 1) What was the extent of enhanced mobility provided the transit dependent population by the elimination of off-peak fares? And 2) Were the effects on mobility for this group comparable to that of the general population? The most direct measure of transit dependency is the availability of a car (either as driver or passenger) as an alternative to the bus for a particular trip. RTD ridership is substantially captive by this measure - about 53 percent of weekday bus trips during the demonstration (47 percent post-demonstration) compared to only about 5 to 10 percent of area travel. Other indicators of low-mobility are income, race, and age.

Table 3.20 shows the estimated proportion of weekday peak and off-peak demonstration bus trips made by low-mobility groups. Persons without access to a car for the trip sampled made slightly more than one-third of peak trips (38%), but nearly two-thirds of free fare peak trips (61%). Proportions of off-peak use substantially higher than peak use were found by each indicator of low-mobility. The greatest relative difference was by age; about four times as many elderly use the off-peak free fare as the peak.

The last column of Table 3.20 indicates the percentage of induced trips which were made by each classification of low-mobility bus users. These are entirely new trips which would not have been made had it not been for the free fare incentive. They provide the best indication of new mobility increases for a particular group since they represent increased tripmaking. In general, the percentage of these new trips made by low-mobility groups is about the same as their share of all

other off-peak trips. This implies that the absolute mobility gains enjoyed by the transportation disadvantaged bus user were generally comparable to their share of all new bus trips due to free fare. The important exception to this finding is the low proportion of elderly making induced trips.

Table 3.20
PEAK, OFF-PEAK DEMONSTRATION BUS TRIPS OF LOW-MOBILITY USERS

Low Mobility Group	Percent of Weekday Demonstration Bus Trips		
	Peak	Off-Peak (Total)	Induced (Only)
No Access to Car	38%	61%	63%
Income below $10,000	33	51	48
Race: Non-White	25	35	35
Age: 16 or less	4	19	20
Age: 65 or more	2	8	3
Percent of Weekday Bus Trips Represented	(35%)	(65%)	(5%)

Source: On-Board Survey (8/78)

Table 3.21 shows that the proportion of the general area population of low-mobility persons which used RTD during the free fare demonstration. It indicates that about 40 percent of the adult population without access to a car used RTD at least once over a week during the demonstration. However, as shown in the second column, the rate of increase in off-peak bus trip-making was about the same, and perhaps slightly less than for the average free fare transit rider (+50%). Persons with incomes below $10,000 and non-whites had a rate of RTD weekly use about double that of the average bus user. The growth rate of off-peak use also was significantly higher for non-whites (+56%) than for whites (+48%). The greatest growth rate was among youths. The percentage of weekly riders who were 65 years of age or older was less than their proportion of the population. Also, the growth rate of off-peak trips was the lowest among the elderly and substantially lower than the average.

Table 3.21
EFFECT ON BUS TRIPMAKING AND POPULATION OF LOW-MOBILITY USERS

Low-Mobility Group	Percent General Population	Users as Percent of Population Subgroup	% Increase[b] Off-Peak Bus Trips
No Access to Car	5%[c]	40%	+48%
Income below $10,000	24	20	+46
Race: Non-White	19	20	+56
Age: 16 or less	29	9	+60
Age: 65 or more	8	7	+30
Average	-	9%	+50%

Source: a) Transit User Survey (10/78); adjusted for probability of selection bias.
b) On-Board Survey (8/78).
c) Random Household (5/79) Bus users 16 years of age or older only.

The overall impact of off-peak free fares on those with potential mobility limitations appears to have been only a relatively small effect of increased mobility. This resulted largely from the fact that RTD was serving a substantial share of the low-mobility persons travel prior to the elimination of fares. The introduction of a fare incentive for off-peak use apparently attracted new bus trips by less transit dependent persons in numbers generally equivalent to those the more captive riders.

3.4 Effect on Trip Characteristics

It was expected that new off-peak bus trips due to elimination of fares would differ from pre-demonstration transit use patterns. Differences in purpose, average distance, and geographic patterns between old and new bus trips could be hypothesized although the magnitude of these differences are not known.

3.4.1 Trip Purposes

As shown in Table 3.22, while the purposes of new off-peak bus trips due to free fare were in fact somewhat different than base off-peak bus trips, the differences between these groups were much smaller than between total peak and off-peak trips. Peak hour trips were dominated by home based work trips (82%), while free fare off-peak

trips were dominated by discretionary trip purposes -- shopping, social-recreational and other, including personal business (46%). Non-home based trips also represented a significant proportion of off-peak bus travel -- 15 percent.

Table 3.22
EFFECT ON PURPOSE OF BUS TRIPS

Trip Purpose	With Free Fare				Without[a] Free Fare
	Peak	Off-Peak			Off-Peak
		New Bus	Prior Peak Bus	Total Off-Peak	(Base)
Home Based:					
Work	82%	33%	29%	34%	35%
Shopping	5	17	29	21	21
Social-Recreational	3	11	11	10	9
School	2	5	4	5	5
Other	4	17	14	15	15
Non-Home Based:	5	17	13	15	15
All Purposes	100%	100%	100%	100%	100%

[a]The distribution of base (without) free fare trips has been estimated from On-Board Survey (8/78) responses of prior off-peak tripmakers.

Source: On-Board Survey (8/78)

The distribution of free fare off-peak trips is almost the same as the base without free fare distribution, only with a somewhat smaller proportion of work trips and a somewhat larger proportion of social-recreational trips. New bus trips attracted by free fares evidenced a higher percentage of non-home based trips and home based "other" trip purposes combined (34%), than previous off-peak bus trips (24%). This provides some indication of highly discretionary travel, including "joyriding."[11] Nearly 40 percent of former walk trips were one of either of these two categories.

[11]Joyriding is a purpose that was not recorded by the On-Board Survey (8/78), however, 2 percent of the respondents to the July preliminary survey stated that they were on the bus solely for the ride. Assuming that joyriding was induced primarily by free-fare, then about 6 percent of the new bus trips were for the purpose of joyriding. This probably underestimates the actual percentage for a number of reasons. Joyriding also appears to have been an activity largely undertaken by individuals under the age os 24, but it was apparently not limited to this age group. Some drivers report that there was joyriding among the elderly.

This finding also suggests that some new trips represented adjuncts to normal daily routine, e.g., workers making midday shopping excursions during their lunch hour. A high percentage of free fare bus trips shifted from peak bus were shopping trips, indicating a relatively high degree of rescheduling of these more discretionary trip purposes.

Table 3.23 shows the estimated rate of off-peak trip increases due to free fare for general trip purposes. Also, the estimated number of additional trips of each purpose is given.

Table 3.23
ADDITIONAL OFF-PEAK TRIPS BY PURPOSE:
WEEKDAY BUS TRIPS

Trip Purpose	% Increase	Additional Free Fare Trips
Home Based:		
Work	+46%	8,300
Shopping	+50	5,300
Social-Recreational	+62	2,900
School	+48	1,200
Other	+55	4,200
Non-Home Based:	+54	4,200
All Purposes	50%	26,000

Source: On-Board Survey (8/78)

3.4.2 Trip Lengths

Average trip lengths were estimated from a sub-sample of the On-Board Survey (8/78) respondents who located their origin and destination on the map provided on the back of the survey form (see Appendix A for a copy of the survey instrument). As shown in Table 3.24 the results of the anlaysis of this sub-sample provide a gross indication of shorter average trip lengths for both new and switched bus trips due to free fare, and consequently a somewhat shorter average trip length for total off-peak free fare trips than base off-peak trips. However, due to limitations in the self-completed geocode information, the analysis of trip lengths is only suggestive of the direction of free fare impacts. A definitive analysis would require additional study.

Table 3.24
EFFECT ON LENGTH OF BUS TRIPS: Average Miles

Service Type	With Free Fare				Without[a] Free Fare
	Peak	Off-Peak			Off-Peak
		New Bus	Prior Peak Bus	Total Off-Peak	(Base)
Regular Routes	5.4	4.7	4.6	4.9	5.0
Express	8.0	-	-	-	-

[a]See footnote of previous Table 3.22

Source: On-Board Survey (8/78); geocoded sub-sample.

It seems likely that this analysis over-estimates the average free fare trip length due to selection bias in the self-administered on-board survey data source. A relatively large number of very short-distance (one or two blocks) trips, as reported to have been common by drivers, may have been grossly undersampled. It is helpful therefore to examine a more detailed breakdown which shows that while 14 percent of the base trips were a distance of two miles or less in length, 21 percent of the new bus trips and 19 percent of the former peak bus trips were this same distance. At the other end of the scale, the reverse pattern prevailed; 7 percent of the new and of the switched trips were for a distance of eight miles or more, but 13 percent of the base trips were for this same distance.

3.4.3 Geographic Distribution

The impacts of free fare on the spatial patterns of bus trips shown in Figure 3.5 are presented using three generalized origin/destination areas of analysis. These include downtown Denver (CBD), other portions of the central city core (Inner Area), and all remaining portions of the MOG service area (Periphery).

As shown in Table 3.25, while the absolute number of CBD bound bus trips increased with free fare, the proportion of transit trips to or from the downtown decreased slightly. In other words, increases in travel by bus to other areas were higher. This is a result of the fact that a somewhat smaller proportion of new bus trips were to or from the CBD (41%), especially from the non-core area (23%). However, the share of within core area (CBD to Inner Area) did increase due to both sources of new off-peak bus travel. Bus travel to and from points within the peripheral (non-core) areas also increased for off-peak trips.

Figure 3.5
MAJOR ORIGIN AND DESTINATION AREAS: City of Denver

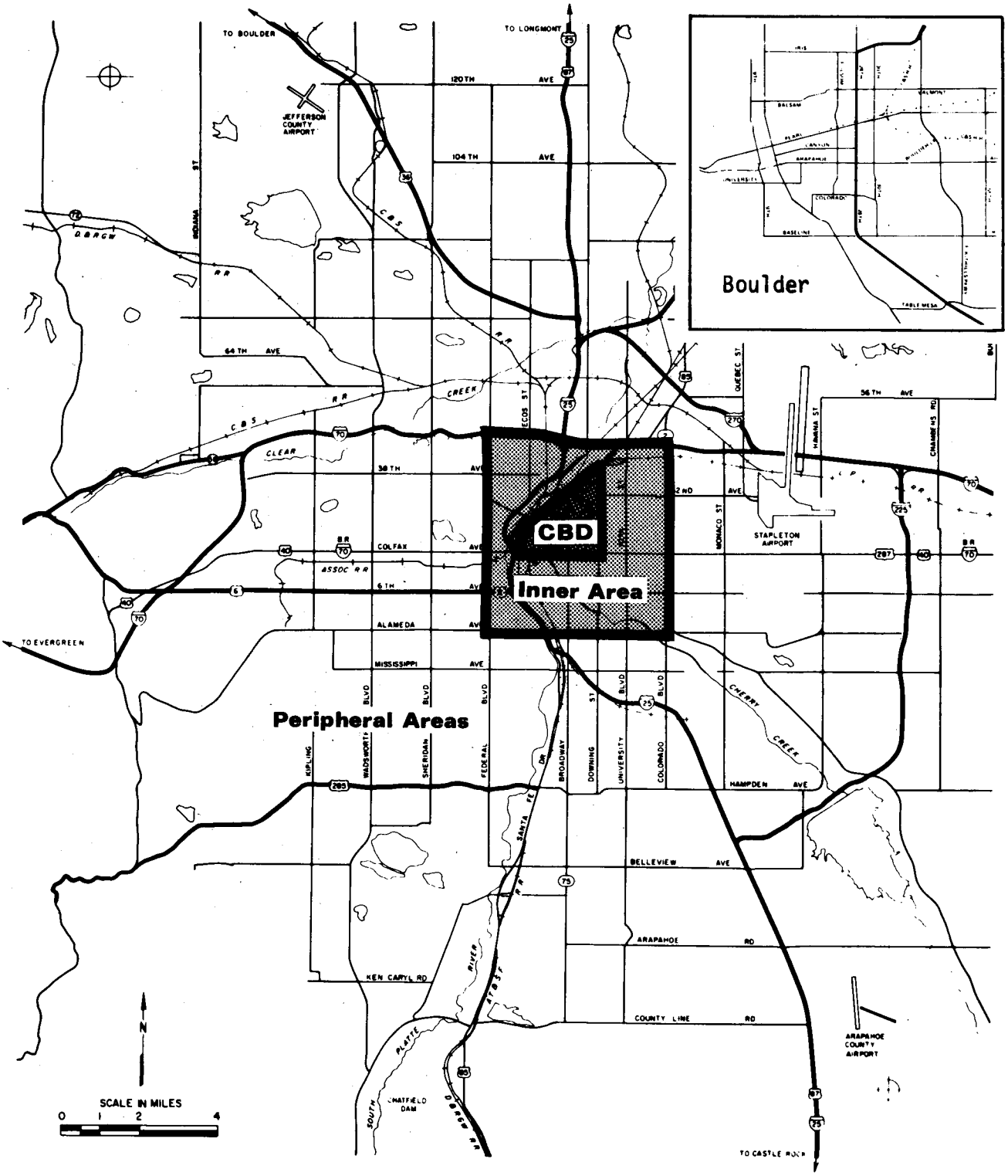


Table 3.25
EFFECT ON GEOGRAPHIC DISTRIBUTION OF BUS TRIPS

Origin-Destination Pair	With Free Fare				Without[a] Free-Fare
	Peak	Off-Peak			Off-Peak (Base)
		New Bus Trips	Prior Peak Bus	Total Off-Peak	
CBD-Inner Area	10%	17%	15%	13%	12%
CBD-Periphery	45	23	29	29	31
CBD-CBD	1	1	1	1	1
Total CBD	56%	41%	45%	43%	44%
Inner Area-Inner Area	27%	27%	23%	27%	28%
Inner Area-Periphery	5	8	7	8	8
Periphery-Periphery	12	25	26	22	20
	100%	100%	100%	100%	100%
Total Weekday Trips Represented	41,000	22,000	10,000	77,500	51,800

[a]See footnote on previous Table 3.22

Source: On-Board Survey 8/78

3.5 Ridership Impact Prediction

3.5.1 Price Elasticity of Demand: Unadjusted

A standard method of reporting findings on the ridership response to a change in fares is to translate the reactions into an estimate of demand elasticities. The central concern is to calculate a price elasticity, a number which is equal to the ratio of the percent change in ridership in response to a 1 percent change in fares. Since a decrease in fares typically leads to an increase in trips taken, the price elasticity has a negative value indicating the opposite movement of the demand for transit trips in response to a change in price. For example, a price elasticity of -.5 means that a 1 percent decrease in fares generates a half-a-percent increase in ridership. The larger the absolute value of the price elasticity, the greater the impact of a percent change in fares and the more "elastic" the travel demand function is said to be.

The usefulness of such elasticities lies in their predictive function. Accurate estimates of elasticities would enable transit operators to project the impact of different pricing policies on ridership and revenues. Moreover, alternative levels of fare savings or revenue effects may be estimated when elasticity values are known for the range of prices considered. The Denver demonstration provides some insight into the price elasticities associated with large fare reductions to zero price, but the findings are fare from definitive. As indicated in the study by Dygert, Holec and Hill, elasticities calibrated to the behavior in one location are seldomly consistent with those in other locations.[12] In fact, the absolute values of observed elasticities range from near zero to almost one. Although there are few explanations for this variation, major factors determining the elasticity probably include the degree of transit usage, demographic composition, and the amount of existing excess capacity.

Other problems with the elasticities calculated from the Denver free fare experience are related to estimation technique and to the simultaneous impact of a change in the quality of bus service. There are several methods of defining the price elasticity (Ep). The method used in the Denver evaluation is an arc elasticity (Arc Ep) computed from the level of demand with and without free fare.[13] This may be interpreted as an average elasticity across the range potential fares defined by the old and the new price. Mathematically, the arc elasticity function is defined as:

$$\text{Arc Ep} = \frac{\Delta Q}{(Q1 + Q2)/2} \div \frac{\Delta P}{(P1 + P2)/2}$$

$$= \frac{\Delta Q\ (P_1 + P_2)}{\Delta P\ (Q_1 + Q_2)}$$

Where:

P_1 = old fare

P_2 = new fare

Q_1 = demand at P_1

Q_2 = demand at P_2

$\Delta Q = Q_2 - Q_1$

$\Delta P = P_2 - P_1$

---

[12] U.S. Department of Transportation, Public Transportation Fare Policy, 1977.

[13] The other approach uses a mathematical model of transit demand to calculate either a point or arc elasticity. The first is the elasticity specific to a point on the demand curve, and the second is an elasticity over a segment of the demand curve. Since there are only two data points from the Denver experiment, it is not possible to generate the demand function without some gross assumptions.

Applying the formula to the observed net change in weekday off-peak ridership, the arc elasticity calculated from the Denver Demonstration yields an estimate of -.20.[14] If the bus trips that were shifted from peak hours to off-peak hours are excluded from the calculations, then the arc elasticity equals -.14 for just the new bus trips. The temporally switched transit trips can be analyzed separately in terms of the interaction between peak-hour trips and off-peak prices. As the price of off-peak trips drops, an increasing number of users substitute off-peak trips for peak-hour trips to take advantage of the lower fares. This response is commonly called cross-substitution, or in economic shorthand "cross-elasticity." Like the price elasticity, the cross-elasticity may be calculated as an arc elasticity. The arc cross-elasticity in Denver during the demonstration project was +.19, which means peak users would switch 0.2 percent of their peak-hour transit trips to off-peak transit trips in response to a 1 percent decrease in off-peak fares.

These estimated price elasticities, however, probably have limited applications. They are best seen as the response to a total reduction in off-peak fares, and are, in most likelihood, inappropriate for relatively small price changes, e.g., a 20 percent increase from $.25 to $.30.[15] In general, the arc elasticity only provides a general indication of increased ridership response to incremental changes within the price range between the old fare ($.25) and the new fare ($.0).

3.5.2 Price Elasticitity Adjusted for Quality of Service Changes

A more serious limitation on the predictive power of the price elasticity estimates results from the fact that the demonstration project was not merely a price change, but also involved some deterioration in the quality of service as the result of increased patronage. The observed change in ridership was in fact a combination of two effects, a price change (holding service constant) and a service change (holding price constant). For convenience, these two effects are referred to as the price response and the service response. The price response was an increase in demand, but the service response was a decrease in demand. Because the former reponse was larger than the latter, the net impact response, an adjusted price arc elasticity may be calculated from the

[14] If weekends are included, then the arc elasticity is equal to -.21. See Appendix E, Table E.4 for estimated variations in arc elasticities among socio-economic groups.

[15] The elasticity around the $.25 base fare may be twice as large as the price elasticity of -.20 reported above. For example, the point elasticity at $.25 equals -.50 if a linear demand curve is fitted to data (or -.41 if an exponential curve is assumed).

price response by filtering out the impact of the decline in the quality of service.[16] Without this adjustment, the price arc elasticity is underestimated.

While the adjustment is conceptually straightforward, its empirical application is more problematic. The price response and the service response occurred simultaneously, so they can not be measured indenendently. Consequently, it is necessary to make an estimate of what the ridership response would have been if there had been no deterioration in service. The post-free fare follow-up survey of transit riders initially sampled in August 1978, give the best available indication of the degree to which perceived service quality decline may have affected the rate of bus use. As shown in Table 3.26, the 13 percent of post-free fare users who report making more trips as a result of ending the program, hold consistently more favorable attitudes regarding the improvement in service resulting from reinstatement of off-peak fares. The percentage of these users who have increased their use of transit after the end of the free fare program is highest with respect to the perception of shorter travel times, a key variable in most ridership prediction models:

Table 3.26
RELATIONSHIP OF PERCEIVED SERVICE QUALITY CHANGES
AND POST-FREE FARE TRANSIT USE

Percent Perceived Improved	More Bus Trips	Same or Fewer Bus Trips
Schedule Reliability	37%	25%
Seat Availability	60	42
Security	37	36
Driver Courtesty	47	33
Travel Time	43	17
Percent Users Represented	(13%)	(87%)

Source: Follow-up Transit User Survey (5/79)

[16] This is done for more than just academic reasons. Changes in the quality of service are not simply related to price levels but are also dependent on the amount of pre-existing excess supply. Thus, under one situation, there may be no deterioration in service and in another, an extensive deterioration. If the reported price elasticity is to be of any transferable use; then it should be related solely to the pure price response. Given this elasticity, an agency can calculate whether or not the price resonse would lead to excess demand given the existing supply.

Based on reported changes in bus use of transit riders in the post-demonstration On-Board Survey (5/79), it is estimated that about 12 percent of the base off-peak trips were either shifted to the peak (8%), shifted to non-bus mode (2%), or were eliminated entirely (2%). See Appendix B, Table B.8. Based on these estimates, the arc elasticity with respect to price only, is estimated to be in the range of -.25 to -.30. This adjusted price arc elasticity is somewhat higher than the simple arc elasticity estimated. However, both the adjusted and the unadjusted estimates indicate that demand for bus transit is relatively inelastic with respect to price. In other words, given the extent of captive ridership, the level of transit use in Denver may be relatively unresponsive to future changes in fares while revenue impacts would be sizable and in the same direction as the fare change.

4.1 Effects on Quality of Service

As a result of the free fare demonstration there was a clear reduction in service levels provided during the off-peak hours. Without major service increases, the additional transit patronage frequently resulted in higher passenger loads on many RTD off-peak buses. Longer travel times, as well as diminished schedule adherence, were more common than before the demonstration. Passenger comfort also deteriorated somewhat due to increased crowding on the buses and an apparent increase in on-board harassment by rowdies and drunks. Degradation of service levels was reflected in bus user and bus driver attitudes, as well as in field observations made as part of evaluation (see Appedix D).

About three-quarters of the transit users surveyed during the demonstration in the first Follow-Up Survey (10/78) indicated that they perceived no measurable impact on most attributes of bus service, with the important exception of seat availability. However, more than 25 percent believed that seat availability had become worse. There is some indication that transit users' opinions about the impacts of free fare had become stronger by the end of the demonstration. As shown in Table 4.1, about 45 percent of the transit users in the sample thought seat availability had improved with the reinstatement of fares. While crowding remained the primary concern, riders also perceived in retrospect fairly strong negative impacts of free fare on security, driver courtesy, and schedule reliability.[1]

Table 4.1
PERCEIVED IMPROVEMENT IN LEVEL OF SERVICE
WITH THE END OF FREE FARES

Bus Service Attribute	Much Better	Somewhat Better	About Same	Somewhat Worse	Much Worse
Seat Availability	22%	23%	50%	3%	2%
Security on Bus	22	18	59	1	-
Driver Courtesy	23	12	62	2	-
Schedule Adherence	14	13	68	4	1
Travel Time on Bus	9	12	72	2	-
Transfer Delay	7	7	42	3	2

Source: Transit User Follow-Up (5/79).

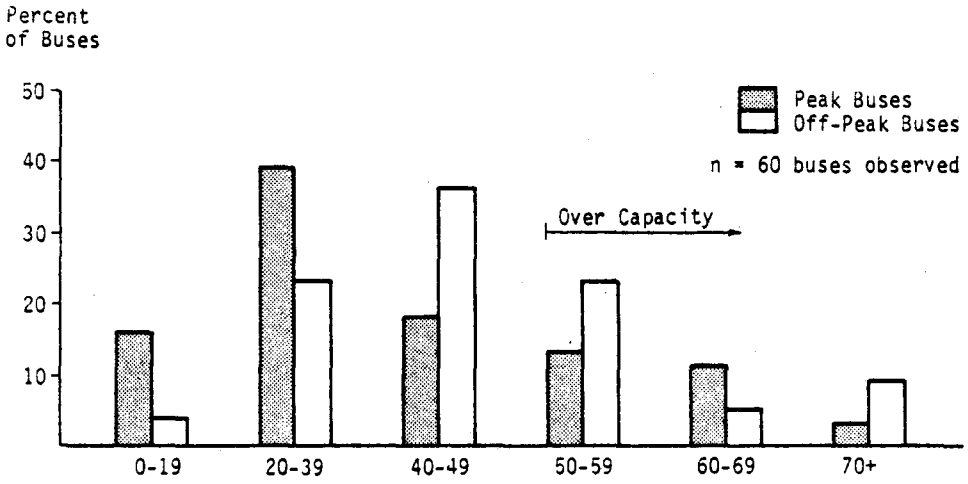
[1] The apparent magnitude of the changes in opinion over time may be affected by the fact that retrospective perceptions are less reliable than current opinions. Selective retention and rationalization of new situational factors tend to show retrospective reports in a negative direction.

4.1.1 Passenger Loads and Crowding

With only minimal additional off-peak service provided, ridership increases due to the demonstration resulted in proportional increases in passenger loads per bus. Bus loads appear to have increased about an average 50 percent during the off-peak. No measurable change in peak load factors has been documented.

Figure 4.1 illustrates the distribution of load characteristics on peak and off-peak afternoon out-bound CBD buses during the demonstration August, 1978. Tabular data from this corner count survey is provided in Appendix D, Table D.3). The results of the survey indicate that off-peak loads may have at times exceeded those of average peak conditions. With an average seated capacity of 51 passengers per bus, the mean average of off-peak buses observed was 45 passengers as compared to 39 passenger on peak buses. In terms of vehicle productivity, it is important to note that the figure shows a sizeable proportion of the off-peak buses operating below, but near capacity in the 40-49 passenger per bus range.

Figure 4.1
EFFECTS ON BUS OCCUPANCY: PASSENGERS OBSERVED PER BUS



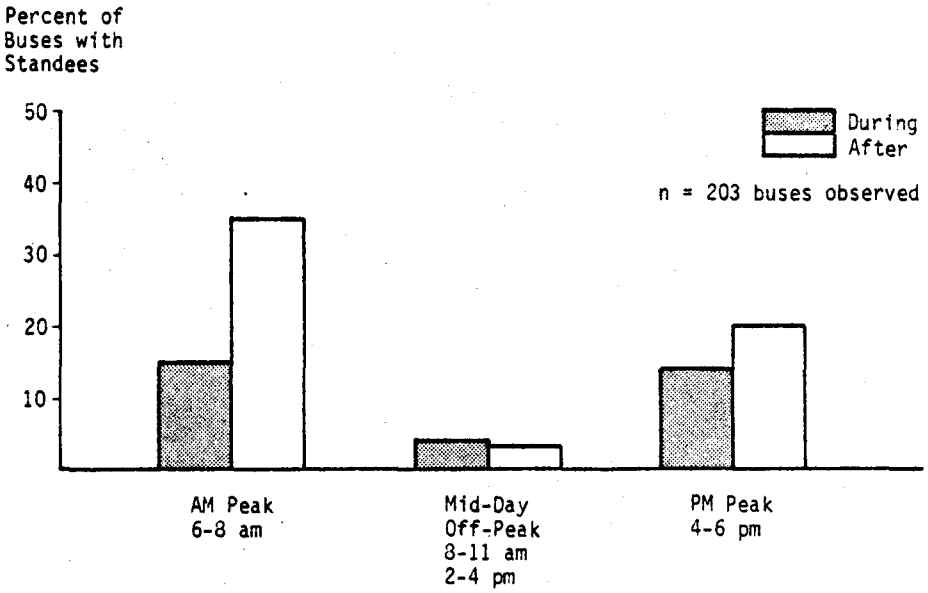
Source: CBD Cordon Corner Counts (8/79). Appendix D, Table D.3.

With increased average loadings, off-peak overcrowding was more common than before the demonstration. As discussed previously, less frequent seating availability was the service attribute about which bus users were the most disturbed. In fact, perceived problems of overcrowding and reduced seat availability brought negative public reaction to the program earlier on. Some farepaying (mostly home-bound) passengers thought they were being discriminated against in favor of non-paying travelers who presumably boarded during the preceding off-peak period and got a seat. This argument appealed to those who felt the free fare program served freeloaders and joyriders at the expense of legitimate travelers, and that it was the peak period which should have been free. In any case, the actual incidence of free riders occupying all seats prior to the peak period was probably relatively small. Changing the morning peak alleviated the problem, since few persons travel before 6 a.m.

In order to gauge the severity of crowding as a result of the off-peak free fare program, it is necessary to assess the extent of over-capacity buses operating during the demonstration. Analysis of the August CBD corner count survey (see Appendix D, Table D.4) indicates that mid-afternoon off-peak crowding conditions during free fares were about the same as those of afternoon peak conditions. Of the nine routes observed in both time periods, none of the buses on two of the routes observed had any standing passengers; two routes had less than 15 percent of their buses with standees during either the peak or off-peak afternoon periods. On the remaining five routes observed, the number of over-capacity buses ranged from 18 percent to 33 percent, and from 18 percent to 40 percent of buses operating on a particular route during the peak and off-peak, respectively. In both periods the average number of standees on overcrowded buses was about 10 riders as the buses crossed the downtown cordon line.

Two special corner counts taken just prior to, and one month after, the demonstration may also be compared. Because of the declining free fare ridership at the very end of the program, as well as the relatively high levels of initial post-demonstration retention, these results probably understate crowding conditions attributable to free fares. As shown on Figure 4.2 (Tabular data in Appendix D, Table D.6), only about 5 percent of all off-peak buses observed during and after the demonstration at route midpoints had standing passengers. While there is no indication in these data of significant change in off-peak crowding, they do suggest that peak hour crowding increased with the termination of free fares as a result of bus users shifting their time of travel back to the peak hours.

Figure 4.2
EFFECT ON BUS CROWDING: BUSES WITH STANDING PASSENGERS
7:00 a.m. - 11:00 a.m., 2:00 p.m. - 6:00 p.m. - Selected Route Midpoint Locations (Eleven Routes)



Source: Special Corner Counts (1/79 and 2/79). Appendix D, Table D.5.

4.1.2 Schedule Adherence

It was expected that off-peak buses would require longer running times as a result of increased stop frequencies and longer on-loading and off-loading dwell times resulting from more passengers using the system. Over 80 percent of RTD drivers sampled indicated that the free fare program caused them to run late more often than before the demonstration.

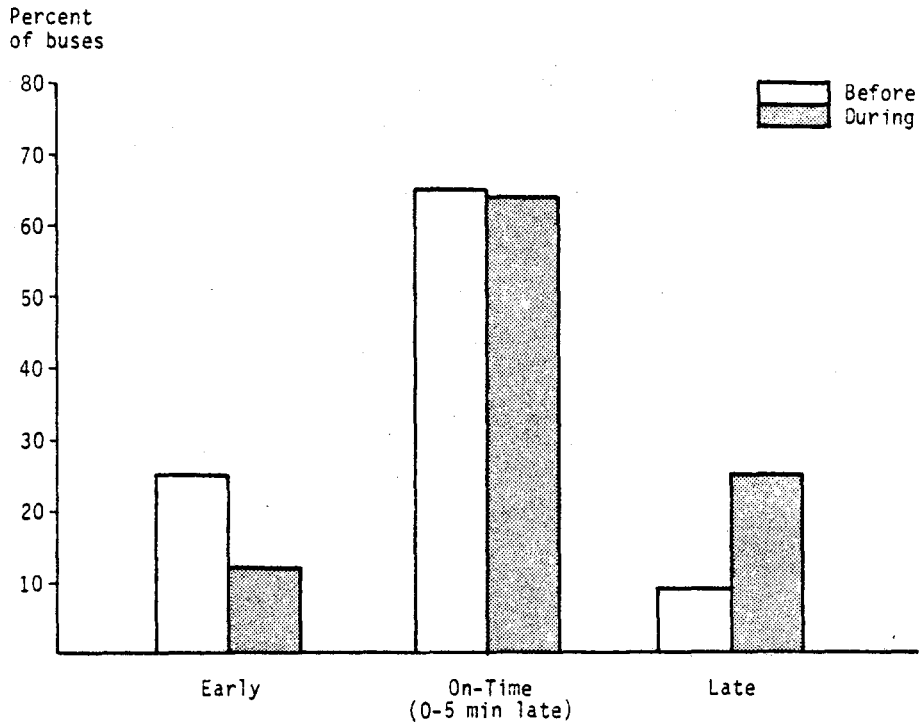
No entirely comparable field observation data is available for the before and during demonstration period for off-peak runs.[2] However, as shown in Figure 4.3, available 1977 data for all day transit operation suggest that while early arrivals were a problem prior to the free fare program, late arrivals were a significant operational problem

[2]Sources of on-time performance data for the before and during periods are different and the degree of comparability is not known. CBD corner count data collected after the demonstration (March 1979) do not provide for a during-after comparison due to the apparent magnitude of route restructuring's effect on schedule reliability.

during the demonstration. (Tabular data provided in Appendix D Table D.2.) Before the off-peak fare program in 1977, average delay (minutes late/buses on-time or late) is estimated to have been 2.5 minutes. During the demonstration it increased to about 4.2 minutes.

About 25 percent of all buses observed were more than 5 minutes late as they crossed the CBD cordon points on the weekday afternoons observed during the demonstration. Peak period schedule adherence problems apparently remained worse than off-peak - 28 percent of peak buses observed late as compared to 18 percent of off-peak. In addition to passenger loadings, this probably also reflects greater vehicular congestion and slower operating speeds during the peak hours. It should be pointed out however, that poor schedule adherence and missed runs during off-peak hours, with typically longer headways, may be perceived as a greater problem by some transit users than a schedule adherence problem of similar magnitude would be during the peak hours, when more frequent service is provided.

Figure 4.3
EFFECTS ON SCHEDULE ADHERENCE: One-Time Performance - Before and During Demonstration



Source: Before - Checker Counts, RTD Scheduling Department (1977)
During - CBD Corridor Counts (8/78)
Appendix D, Table D.2.

4.1.3 On-Board Security

Perhaps the most publicized negative impact of the free fare program was the perceived increase in the occurrence of on-board harrassment, violence, drunkenness, and vandalism. Based on the survey responses of drivers, passengers, and Denver metropolitan area households, there was a strong perception of a marked decrease in personal security on RTD buses, primarily as a result of abusive juveniles and other "undesirables" including drunks.

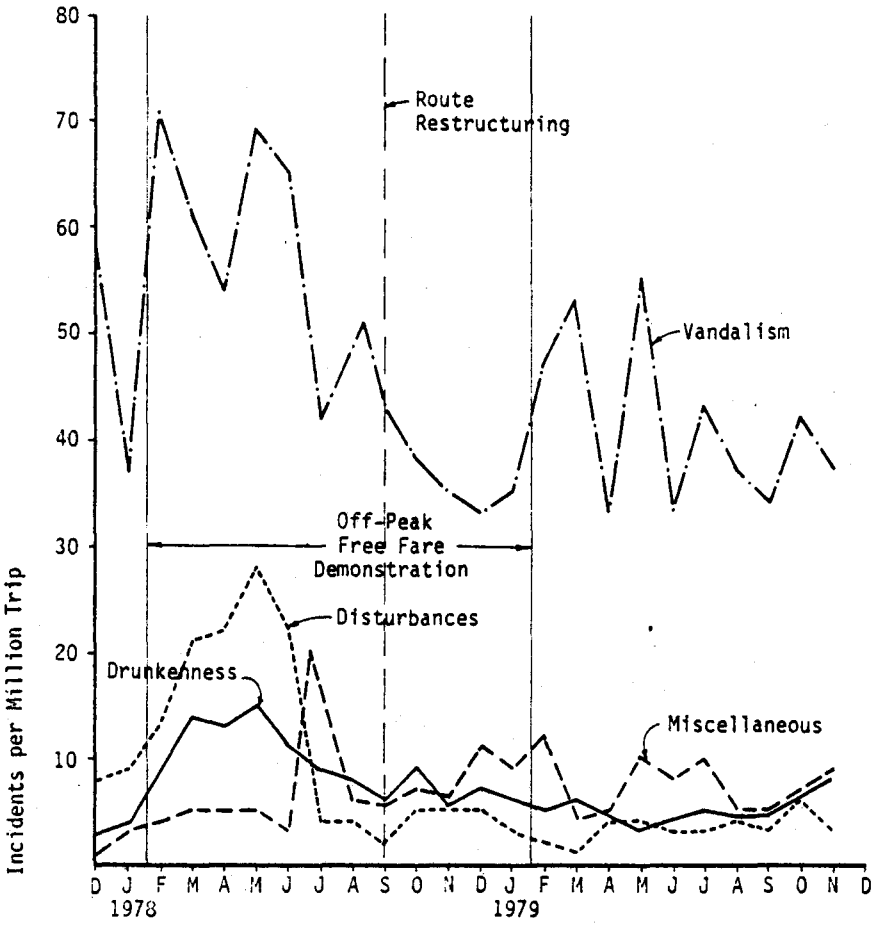
In October and November 1977 about eight off-duty police were hired on a part-time basis to provide security on RTD buses. In February 1978, the security force was increased to 15 full-time employees. This increase can not be attributed to the free-fare program. In fact, the augmented security may have resulted in a greater degree of on-board crime detection, and thereby indirectly tends to overstate the before-during difference in reported incidents.

Boisterous behavior by youths including smoking/eating on the bus and loud/profane language were reported to be most common during the 2:00 to 3:00 p.m. midday off-peak period during the school months. School children who would otherwise walk or use the school system bus would frequently board an RTD bus in large numbers. The dynamics of peer group behavior appears to have aggrevated the degree of disturbance caused by school aged free fare riders. These problems appear to have been mitigated by selective enforcement, but more effectively countered by public relations activities directed at school children. (See Section 2.5.3.2).

RTD only began maintaining complete records of security incidents in December 1977. Consequently it is not possible to compare during demonstration data with more than the two months immediately prior to the program. During these months however, the number of incidents as shown in Figure 4.4 was considerably lower than in the early months of the free fare program.

Vandalism, and in particular, seat slashing appears to have increased drastically with the elimination of off-peak fares. Incidents of drunkenness and assaults, on both passengers and drivers also appear to have increased substantially per million bus trips as a result of the free fare program. Incidents of drunkenness and disturbances (including assaults) peaked in the fourth month of the program (May 1978). The rate of drunkenness remained higher throughout 1978 than similar data for 1979. However, the incidence of disturbances per million bus trips dropped after June 1978 to levels nearly equivalent to those of the 1979 rate.

Figure 4.4
EFFECT ON SECURITY INDICATORS



Source: RTD, Office of Policy Analysis

4.2 Effects on Service Operations

Overall, the off-peak free fare demonstration had only minimal impact on Denver RTD transit operations. Despite deterioration of off-peak service levels due to heavier passenger loads, off-peak service levels during the demonstration generally became no worse than peak period problems. Major additions to off-peak bus service were not provided as a means to maintain off-peak service levels comparable to before the demonstration. This would have been inconsistent with the objective of achieving greater vehicle productivity for existing off-peak service. However, a small increment of service was required to solve the more serious problems on several of the most heavily used routes.

4.2.1 Fleet Inventory and Utilization

As of January 1978, Denver RTD had a fleet inventory of 504 motor coaches. By March, 231 new coaches had been received, expanding RTD's fleet to about 590 buses after retiring about 145 of its former coaches. After March, about 420 coaches were utilized during peak hours and about 260 during off-peak hours on a typical weekday. Saturday and Sunday service were increased substantially in March with about 180 and 75 buses used for each of these days, respectively. RTD reports that the extra service implemented with the March run-board changes, particularly the expanded weekend service, resulted in an over-committed fleet which lead to increased maintenance problems. However, this extra service provided had been planned well in advance of the conception of the free fare program. Much of this new service was cut back in June, resulting in a more workable active-to-spare vehicle ratio.

However, directly as a result of the impacts of increased off-peak patronage, in April RTD determined the need to put 18 additonal coaches into off-peak weekday service, representing a 5 percent increase in off-peak vehicle assignment. Service on the high patronage 15-Colfax route was augmented with six of these, four were assigned to three other Denver regular routes, three served as extra trippers, and five were used on Intercity runs. On Saturdays, nine additional buses were put into service, about a 5 percent increase in Saturday vehicle utilization.

4.2.2 Service Miles and Hours

As shown in Table 4.2 average monthly mileage and hours of service were substantially higher during the pre-route restructuring phase of the demonstration than during these months one year previously.[2] While this increase in service may have mitigated the operational impacts of free fare, only a small fraction of it was implemented in response to the increased demand associated with free fare. It should be noted, that ridership estimates (see Appendix B) of RTD patronage without free fare have been adjusted upward to reflect these increased service levels.

Table 4.2
AVERAGE MONTHLY BUS MILES AND HOURS: BEFORE, DURING, AND AFTER DEMONSTRATION -- TOTAL RTD SCHEDULE SERVICE

	Service Miles		Service Hours	
	Thousands	% Annual Increase	Thousands	% Annual Increase
1977: Before[a]	1560	-	112	-
1978: During[a]	1800	+15%	126	+13%
1979: After[b]	1870	+4%	133	+6%

a. February through August
b. February through May

Source: RTD Monthly Performance Reports. Appendix C.

[2] See Appendix C for detailed operating revenue and performance indicator data (by month) for the before, during, and after demonstration periods.

The additional service requirements for which RTD implemented new free-fare off-peak service were generally limited to a few of the most heavily used routes. The four routes which were assigned additional weekday service carried about 40 percent of all passengers carried on the 37 regular service routes operated by RTD during the pre-route restructuring phase of the demonstration. Table 4.3 shows the additional hours and miles put into service. Based on estimates of average totals for all MOG scheduled service during the March through May 1978 period, there was about a one percent increase in total off-peak weekday, and about a two percent increase in Saturday service parameters.

Table 4.3
EFFECT ON TRANSIT OPERATIONS RTD SCHEDULED SERVICE (MOG Only)

Additional Service Required	Implemented Spring 1978		
	Service Hours	Pay Hours	Service Miles
Weekday			
• 4 Regular Routes	19	24	338
• Trippers	21	21	120
Total Extra	40	45	458
Total Weekday	4,700	5,300	66,600
% Represented	0.9%	1.0%	0.7%
Off-Peak Weekday	3,100	-	46,600
% Represented	1.3%	-	1.0%
Saturday			
• 4 Regular Routes	49	64	416
• Trippers	7	11	56
Total Extra	56	75	572
Total Saturday	2,390	2,710	36,000
% Additional	2.3%	3.1%	1.6%

Source: RTD: Office of Policy Analysis

The distribution of peak and off-peak hours of service on a typical weekday did not change substantially as a result of the free fare program. Table 4.4 shows the peak to off-peak service hours split estimated for several key points in time. It illustrates that there has been a slight proportional increase in off-peak service over time, beginning before and continuing during the demonstration. While average weekday hours increased about 13 percent, off-peak hours increased about 14 percent from 1977 to 1978.

Table 4.4
AVERAGE WEEKDAY BUS HOURS OF SERVICE: RTD REGULAR ROUTE SERVICE ONLY

Time Frame	Percentage of Bus Hours		Bus Hours
	Peak	Off-Peak	Weekday
Pre-Free Fare (August 1977)	29.3%	70.7%	3340
During Free Fare/Pre-Route Restructuring (August 1978)	28.7%	71.3%	3500
During Free Fare/Post-Route Restructuring (September 1978)	27.9%	72.1%	3820
Post Free Fare/Post-Route Restructuring (March 1979)	27.9%	72.1%	4060

Source: RTD, Operations Division; Routes and Schedules

Another potential operational impact of the free fare program was an effect on efficiency as measured by change in the ratio of service hours to total pay hours. Service hour data available for RTD's operations include all assigned runs and trippers as well as extra runs. Non-service hours include overtime hours as well as other hours such as spread time, interviewing time, instruction time, etc. Free fare apparently had little or no effect on this measure of efficiency. During free fare, non-service hours represented 12.1 percent of total hours, slightly less than during comparable months in 1977. There is no data available from RTD on the effect of the free fare program on deadhead miles, but given the no-impact finding regarding non-service bus hours, it must be assumed that deadhead miles as a proportion of total miles (about 10 percent of regular service hours) were virtually unaffected by the additional service requirements.

4.2.3 Effects on Systems Productivity

The estimated total ridership for the one-year demonstration period was 34.3 million; 23.9 million (70%) during off-peak periods. Had there not been fare-free bus service the projected ridership during the same twelve months would have been 26.1 million passengers; 15.7 million (60%) during off-peak weekdays and on weekends.

Based on estimates (from Table 4.4) of the percentage of service hours provided during the off-peak periods, the proportion of service miles operated during the demonstration in the off-peak periods was estimated, accounting for slightly faster off-peak operating speeds than peak period speeds.[3] Without-free fare base estimates were developed which reflect the minor service changes directly attributable to the demonstration. The estimated values of common performance indicators are shown in Table 4.5. Examination of the productivity indicators in the table clearly illustrates the effectiveness of the fare-free demonstration in increasing ridership relative to the supply-side resource investment. The free fare program increased overall system productivity by raising off-peak vehicle productivity to levels higher than in pre-demonstration peak periods with no real measurable loss in peak productivity.

Table 4.5
EFFECTS ON PRODUCTIVITY: TOTAL RTD REGULAR ROUTES SERVICE -- (UNLINKED TRIPS) AVERAGE WEEKDAY

Indicator	With Off-Peak Free Fares	Without Off-Peak Free Fares	Free Fare Percent Increase
Passengers Per Mile			
Off-Peak	2.4	1.6	50%
Peak	2.6	2.6	-
Total	2.5	1.9	30%
Passengers Per Hour			
Off-Peak	32.3	21.7	48%
Peak	31.5	31.8	-
Total	32.1	25.0	28%
Passengers Per Dollar*			
Off-Peak	1.22	1.01	21%
Peak	1.49	1.49	-
Total	1.32	1.18	12%

*Linked Trips (Person Trips) per Net Cost. Inverse of subsidy per passenger (see Section 4.3.3).

Source: Appendix B and Appendix C

[3] RTD Scheduling Department estimates that typical operating speeds are about 10 percent slower than off-peak during the peak period.

Supply-based productivity analysis illustrates the relationship between free fare generated ridership and added supply, but is incomplete because it does not consider the total cost of generating the new ridership. It neglects the effects of the loss of off-peak revenue and the cost of the added service however small that may be. The indicator of passengers per subsidy dollar does consider these factors. As shown in the table, the fare-free service registered an improvement in this category as well. The free fare effect shows that the gain in passengers relative to the resource investment was larger than prior off-peak performance on the system, even with consideration of revenue loss, as well as additional operating costs.

4.2.4 Effects on Maintenance

Given the relatively small increment of service added as a result of the free fare program, only minimal mileage-related maintenance costs would have been expected. The additional routine maintenance costs were less than one half of one percent of the total 1978 RTD maintenance expenditures of about 10 million dollars during the demonstration year.

Vandalism

While it has not been possible to quantify any additional general wear and tear on equipment as a result of the heavier free fare passenger loads, some additional maintenance and equipment repair costs may be allocated to increased vandalism attributable to the free fare program. RTD maintenance staff reports that about 170 incidents of vandalism typically occurred each month during the year prior to the demonstration. Vandalism occurred at an average of 232 incidents per month during the first five months of the demonstration. From July 1978 on, acts of vandalism declined and the rate of incidents per million bus trips was roughly equivalent to 1979 levels. Table 4.6 shows that vandalism incidents during the total one year demonstration were about 40 percent higher than during 1979 when ridership was about 20 percent less.

Repair of broken windows and replacement of slashed seats represented most of the extra maintenance work. Normal frequent bus washing apparently minimized any extra costs resulting from increased graffiti on buses. The frequency of vandalism was highest in the early months of the program. As discussed previously, a concerted public relation effort, aimed at encouraging respect for RTD buses was made in the late Spring of 1978. Vandalism did decline during the subsquent summer months and remained at normal levels once school resumed in the Fall. It is estimated that vandalism due to free fare resulted in about $25,000 additional maintenance repair costs over the life of the program.

Accidents

There was an apparent small increase in the accident rate experienced by RTD as a result of free fares during the initial months of the program. During February and March 1978, the accident rate rose

Table 4.6
INCIDENTS OF VANDALISM: DURING AND
AFTER FREE FARE DEMONSTRATION

Month	A During Demonstration (1978)	B Post-Demonstration (1979)	C Percent Higher (A/B)
February	232	136	171
March	238	169	141
April	194	103	188
May	254	164	155
June	244	98	249
July	154	130	118
August	199	118	169
September	152*	105	145
October	144	147	98
November	129	120	115
December	115	n.a.	n.a.
January	127	n.a.	n.a.
TOTAL INCIDENTS	2,182	(1,290)	n.a.
AVERAGE NUMBER PER MONTH	181.3	129	141

*Route Restructuring Implemented (9/10/78).

Source: RTD, Office of Policy Analysis.

to about 85 vehicle accidents per 1 million miles of operation. However, in the following months prior to route restructuring, the vehicle accident rate returned to normal pre-free fare levels of about 65 to 70 per million miles of service. Neither the number nor the severity of accidents involving passengers appear to have been affected by the free fare demonstration after March 1978.

4.2.5 Effects on Labor

The principal labor impact of the free fare program was on bus driver working conditions and attitudes. With the exception of February (Transit Awareness Month) when twelve extra temporary drivers were used, no significant increase in driver assignments during the program year can be attributed to free fare. However, the free fare program did have a major negative impact on the on-board working environment for many drivers.

While generally favorable to a short-term free fare program as originally conceived, by July, 250 drivers had petitioned the RTD Board to discontinue the program. In a survey conducted by RTD as part of the evaluation, nearly one-quarter of the drivers sampled reported that they had requested a change in assignment as a result of the free fare program (see Appendix D, Table D.6). The president of the local drivers union indicated in an interview that as many as 40 or 50 experienced drivers were lost to other transit systems as a result of the program. Available manpower records of RTD show that lost time (including sick, vacation, holidays, and attrition) constituted about 18 percent of total service hours during the demonstration. Since no comparable data is available for the year prior to the program, the data can not be used to corroborate this indication that there was an increase in lost manpower due to free fares.

Most problems for drivers were related to the increased difficulty in maintaining schedules. A substantial increase in complaints were registered against drivers being rude, speeding, and passing by waiting passengers. Four out of five drivers surveyed reported that the free fare program caused them to run late more often than before. A second set of problems for drivers is that associated with the quality of interaction with the bus using public. Fare disputes were a problem early in the program, but increased rowdyism and vandalism were a more persistent and burdensome problem. The most often cited negative effect of the program by drivers was the increase in "undesirable" passengers. The personal security of drivers was also threatened as they were frequently cast into the role of disciplinarians of unruly and abusive youths.

4.3 Financial Impacts

The net financial impacts of a free fare program on the transit service providing agency is the sum of the extra expenditures (costs) required to implement the program and fare revenues not collected (loss). Sources of local and federal funding for the program are

discussed in Section 2.0, "Implementation Issues." This section also examines the impact of the free fare program on transit subsidies and on post-program fare revenues.

4.3.1 Program Costs

The costs of implementing free fare may be categorized as administrative, program development and operating. In Denver, each of these major types of costs were small relative to the overall RTD operating budget of 38.8 million dollars during the year-long demonstration. The marginal costs of adding the small increments of service which were required for the free fare program were apparently somewhat less than the average costs of $1.71 per mile during 1978.[4] Figure 4.5 shows the trend in estimated monthly operating costs for RTD scheduled service from January 1977 to June 1979. The figure illustrates that free fare had only a very minor impact on overall operating costs.

Proportionately higher than total program costs were incurred with respect to program development, including information services, marketing, program monitoring and planning. Estimates of these costs are given in Table 4.7. Since these figures have been developed from numerous sources of unaudited financial data, and of varying degrees of reliability, they should be viewed only as estimates of the relative magnitudes of program component costs.

About one-quarter of the 12 month program costs may be allocated to the first month "Transit Awareness Month." This involved an all-day free transit day and extensive transit promotional activities, which may have exceeded the level required for a free fare program start-up elsewhere. Total average costs following the first month were about an average of 50 thousand dollars per month and apparently, more or less constant over the duration of the program.

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[4] Estimated total weekday operating costs during the demonstration were about $111,000 of which about $63,500 may be attributed to off-peak operations, about 1.2 percent more than off-peak weekday costs without free fare. This calculation results from allocation of 1) 70 percent of non-service hourly costs to the peak, 2) service hour and mileage related costs proportional to peak/off-peak distribution and 3) non-mileage (fixed operating overhead) costs portional to the distribution of service and non-service hours combined. Annualized capital costs have been ignored.

Table 4.7
ESTIMATED FREE FARE DEMONSTRATION COSTS
(UNAUDITED ESTIMATES)

Program Component	February 1978	Subsequent Months	Total Demonstration
Program Administration	$ 2,000	$ 11,000	$ 13,000
Program Development			
Information and Marketing	45,000	75,000	120,000
Planning, Data Collection, and Monitoring of Free Fare	40,000	185,000	225,000
Operating	67,000	275,000	342,000
Added Service			
Increased Maintenance			
Routine (Mileage)	20,000	20,000	40,000
Vandalism	-	25,000	25,000
Total Costs	$175,000	$590,000	$765,000

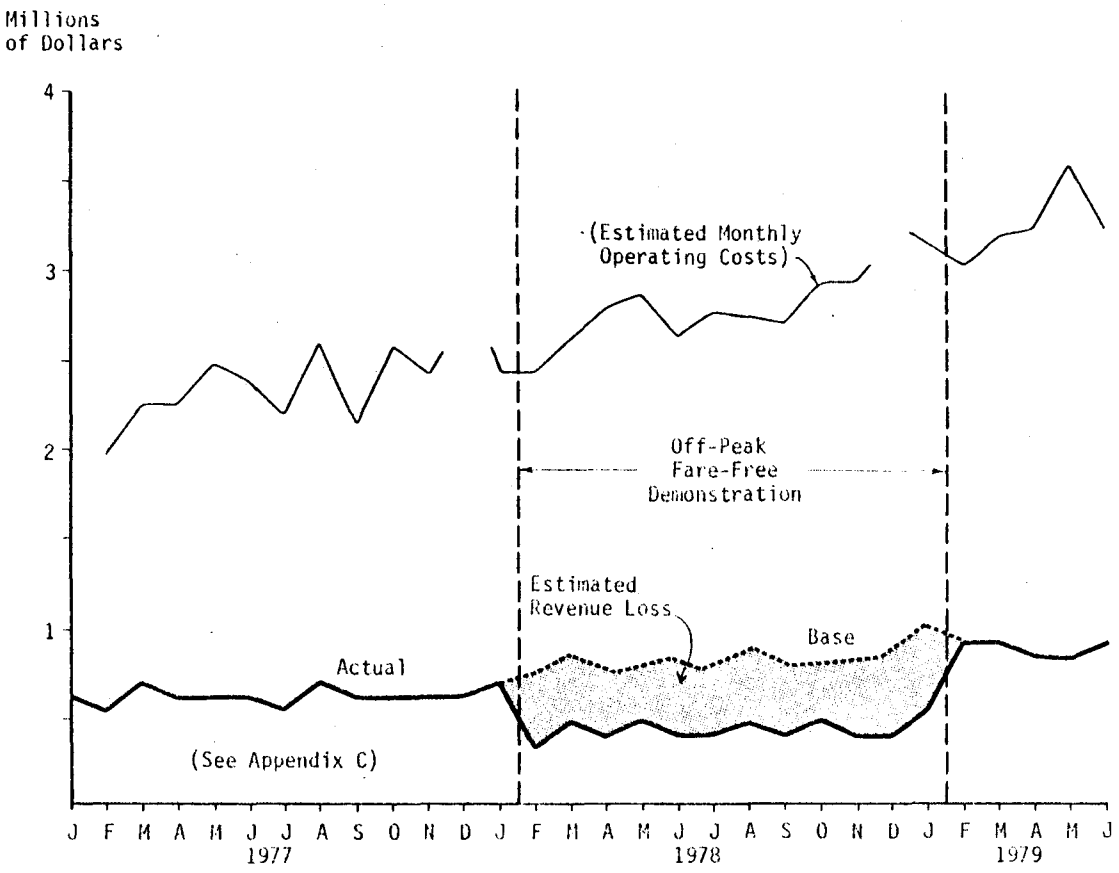
Source: RTD; Operations Division, Office of Policy Analysis, and Marketing Section.

4.3.2 Revenue Loss

Revenues lost from eliminating off-peak fares constituted the overwhelming proportion of the monetary costs of the demonstration program. A comparison with the revenues and average fares collected in the previous twelve months provides an indication of the financial impact. From February 1976 to February 1977 RTD collected $8.04 million in fares but it collected only $5.28 million during the year-long demonstration project.[5] At the same time the average fare per passenger (unlinked trip) declined by 48 percent - from $.241 to $.116. The trends in revenues and the estimated revenue loss is shown in Figure 4.6.

[5]Revenues reflect total RTD scheduled service: Regular, Express, Circulator, Intercity, and Airporter. Excludes charter, special freight and elderly and handicapped (see Appendix C).

Figure 4.5
ESTIMATED MONTHLY OPERATING REVENUES (and Costs)
Total RTD Scheduled Service



Source: Appendix C

Because of the fare increase in January, the revenue loss due to the elimination of off-peak fares was more than the difference between the revenues collected during 1978 and the revenues collected in 1977. Without free fare, the fare schedule increases introduced at the beginning of 1978 would have allowed RTD to collect more than $9 million in revenue during the twelve months coinciding with the program.

The crucial element in calculating the revenue loss is estimating the revenue that would have been collected in the absence of free fare (base revenue). The estimate is based on an assumption that the first month's experience with the new price schedule (but before free-fare) is the best indication of the increases in revenues that

would have been experienced without the free fare program. Revenues collected in January 1978 were 16 percent higher than the revenues collected during the same month in 1977. Assuming the same effect for the period from February 1978 to January 1979, the base revenue would have been about $9.28 million. The corresponding revenue loss would be a little less than four million dollars.[6]

Table 4.8
ESTIMATION OF REVENUE LOSS DUE TO FREE FARE PROGRAM (Millions)

Pre Free Fare: February 1977 to February 1978			
A.	February through December 1977		$7.27
B.	January 1978 (With Fare Increase)		
	Pass Sales	.195	
	Fare Revenue	.575	
	Total	$.770	
C.	January 1978 (Without Fare Increase)		
	January 1977	.661	
	Percent Annual 1977/1976 Increase	x1.056	
		.698	.70
D.	Preceeding Year		$7.97
During Free Fare: February 1978 to February 1979			
E.	Base = $\frac{\text{January 1978}}{\text{January 1977}}$ x (D)		$9.28
F.	Actual		
	Collected	$5.28	
	Effect of Route Restructuring	.06	
	Estimate Free Fare	$5.34	$5.34
G.	Estimate Free Fare Revenue Loss		$3.94

Source: Appendix C

The $3.94 million loss can be attributed to two sources: the revenues lost from fares that would have been paid by the regular off-peak users and the net revenues lost from peak hour users who switched

[6]This sum may be a high estimate of the loss. An alternative method of calculating the base revenue is to multiply the estimated base ridership times the estimated average fare. Using this method, the net loss in revenues is estimated to be $3.6 million.

to off-peak trips to take advantage of the free fare. These temporal shifters cost RTD $1.09 million in uncollected fares.[7] However, the revenue loss due to these trips was surpassed by the additional revenue from new peak-hour rides that were spillovers or other free fare related new peak trips. The net effect on peak hour revenues appears to have been a small positive impact.

Table 4.9
COMPONENTS OF REVENUE LOSS

Source	Revenue Loss (Millions)
Loss Off-Peak Revenues	-3.96
Loss Revenues from Switchers	-1.10
New Peak Hour Revenues	+1.12
Net Revenue Loss	-3.94

Source: RTD Revenues, Appendix C; On-Board Survey (8/78)

4.3.3 Transit Subsidy

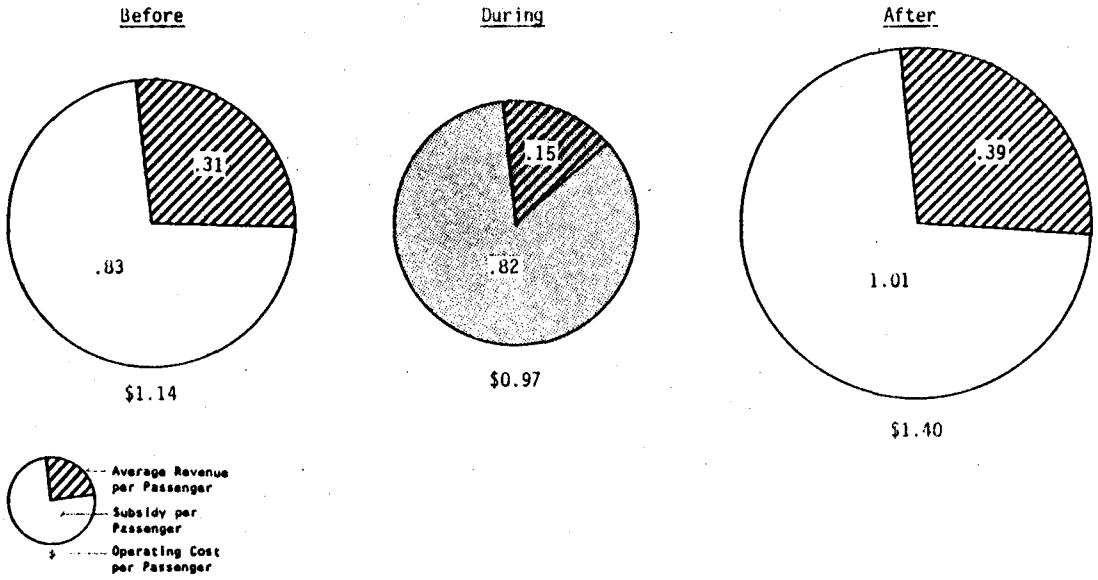
An unavoidable consequence of the elimination of fares during non-peak hours was its impact on public subsidies needed to support bus transit. Although it is impossible here to examine the total subsidy because of the lack of information on capital costs, it is possible to examine the impact on subsidies related to operating costs. To facilitate the analysis, it is assumed that fare revenues were collected primarily to offset operating costs.

In absolute dollars, free fare increased the amount of subsidy. If off-peak hour fares had been collected, total fare revenues would have covered 27 percent of the estimated 35.0 million dollars in the variable costs of total RTD scheduled service (without free fare program). This recovery rate is nearly identical to the proportion of operating costs which was covered by fare revenues during the twelve months prior to the project. With free fare however, revenues dropped by more than 42 percent to $5.3 million, which covered only 15 percent of the total operating cost during free fare. This meant that non-fare revenue sources used to meet the remaining costs increased by over

[7] Revenue loss during peak hours due to switching are calculated by multiplying the number of switched trips times an estimated average peak hour fare. Actual calculations: (10,400 trips/day) (255 days)($.412/trips). Revenue gain is attributed only to the period from February to August 1978, the period prior to route restructuring.

19 percent, from $25.2 million to $29.9 million and covered 85 percent of the operating budget. In other words, because of free fare the general public paid 85 cents instead of 73 cents for every dollar spent on the operations of bus transit in Denver.

Figure 4.6
EFFECT ON SUBSIDY PER PASSENGER: TOTAL RTD SCHEDULED SERVICE - Weekday, Saturday, and Sunday (Dollars per Person Trip)



Source: Appendix B and C

However, in terms of the subsidy per passenger, free fare had the opposite impact due to the dramatic increase in off-peak ridership. Figure 4.7 shows the trend in expenses, revenues, and subsidies for total weekly linked-trips. Compared to the year prior to the demonstration project, free fare decreased both average operating cost and average revenue per passenger made by bus, while the subsidy per passenger remained about the same (82¢). This comparison, however, underestimates the impact since the introduction of a higher fare schedule in January 1978 altered revenue structure. Without free fare, the statistics during the demonstration year would have been similar to

those in the post-free fare period. Consequently, free fare appears to have held down average cost and subsidy per passenger to an even greater degree than first indicated.[8] The decrease in both the average cost and subsidy per passenger is simply due to the fact that total ridership increased more than the total cost and total subsidies. Although the total revenue lost was substantial relative to prior revenues collected, it represented only a small proportion of the total subsidy. While the total subsidy during the free fare program increased by 19 percent, total ridership increased by 32 percent. These findings indicate that RTD reduced the average subsidy, while increasing total subsidies, as a result of more efficient use of excess off-peak period capacity.

4.3.4 Post-Program Financial Impacts

There appears to have been no residual cost impacts of the free fare program. It is not possible to identify any cost component of post-demonstration service that can be attributed to the free fare program. However, additional fare revenues resulting from retained free fare trips can be estimated.

If the projected retention rate of about 17 percent of free fare ridership gains continues uninterrupted and is attributed solely to the long-term effect of free fare, then RTD may recover a sizeable proportion of the foregone fare revenues. Assuming no disruption in the level of retention for five years, RTD will recover $2.3 million to $2.5 million, depending on the discount rate considered appropriate to the analysis.

The assumption of longer periods of retention, yields higher revenue returns, but it is important to note that RTD will not recover all the free fare loss within a reasonable time horizon.[9] Table 4.10 presents the projected revenue returns in present (1978) dollars assuming various discount rates.

The actual revenue returns due only to free fare are probably much less than the maximum $2.5 million shown in the table. An external event, such as a sustained gasoline shortage, could be expected to have nearly the same impact as free fare had in activating latent transit demand. If so, the stream of future returns attributable to free fare would drop to zero. Also, normal attrition will steadily cut into the level of initial retention. Both of these factors could reduce the size of long-term free fare revenue returns.

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[8] Average subsidy per off-peak weekday trip dropped from 97¢ to 82¢ because of free fare. There was no noticeable effect on peak-hour subsidy, which was about 67¢ per trip. While the average peak hour operational cost subsidy was lower, it would probably be higher than the average off-peak subsidy if capital costs were included in the calculation.

[9] For example, within 15 years and at an 8 percent discount rate, total returns is about $3.8 million, which is slightly less than the total loss.

Table 4.10
BEST CASE ESTIMATES OF POST-FREE FARE REVENUE IMPACT (In Millions)

Number of Years Without Substitute Event	Alternative Discount Rates		
	8%	10%	12%
One Year	$ .67	$ .66	$ .66
Three Years	$1.66	$1.61	$1.57
Five Years	$2.50	$2.39	$2.22

Source: DCCO Estimates - Appendix B and Section 3.1.4

Assuming that long-term retention declines by about 10 percent each year due to attrition, the expected total free fare revenue return in five years (at 8 percent discount rate) would be in the range of from $.6 million to $1.2 million, depending on the likelihood of some other transit use stimulating occurrence (within 1 to 3 years). This suggests that the long-term revenue increase due to the program, may be about 15 percent to 30 percent of free fare revenue losses.

5.0 SECONDARY EFFECTS

This section focuses on the secondary impacts of the free fare demonstration which occurred as a result of the program's direct effects on transit use and operations. It should be noted that estimates of secondary effects of the program have been developed from the transit and telephone survey data collected in the evaluation. In most cases, primary data obtained from field observation were not available.

5.1 Environmental Impacts

The indirect effects of the demonstration on the Denver metropolitan area environment, and the program's contribution to energy conservation objectives, are both related to the extent of auto travel diverted to transit because of free fares.

5.1.1 Auto Travel and Vehicle Miles of Travel

Based on the August On-Board Survey results and the adjusted ridership estimates, it appears that about 12,000 bus trips during the free fare demonstration were diverted from the auto mode on a typical weekday. About 62 percent of these (or 7,200) were trips which would have been made as auto drivers. To allow for an estimate of the maximum impact, it may be assumed for this analysis that all the former auto passenger trips were vehicle trips which were also eliminated by the change in mode of the free fare bus rider.

Previous transportation studies in Denver indicate an average trip length of about 6 miles for internal trips.[1] Consequently, as many as 60,000 to 90,000 vehicle miles of travel (VMT) may have been eliminated on a typical weekday due to shifting of auto drivers and passengers to transit. Total daily VMT in the Denver Metropolitan Area during 1978 was about 17.5 million. Diversion of auto drivers to transit thus appears to have reduced total regional VMT by about one-half of one percent. This is less than the normal day-to-day variation and would not be detectable by the traffic counting programs. This level of reduced vehicle mileage represents about one-sixth that required of public transportation by Colorado's EPA mandated State Implementation Plan for air quality attainment.

5.1.2 Air Quality and Energy Conservation

A similar conclusion applies to air quality effects. While any reduction in auto travel reduces mobile source pollutant levels, the reduction which may have been due to auto-transit mode shift can not be distinguished from normal daily variations caused by weather effects or changes in background traffic volumes. Given the fact that transit

[1] A small sample of free fare transit users who switched from driving their automobile (On-Board Survey, 8/78) suggests that the average trip length for these former auto trips may be shorter than the regional average.

carries less than 3 percent of all area travel, even a 100 percent increase in transit ridership by auto drivers could be expected to reduce VMT and related regional air pollution by only a small amount (about 3%).

If we assume an average gosoline consumption rate of 14 miles per gallon for the Denver urban area, the estimated reduction in VMT translates into a savings of about 6000 gallons of fuel on an average weekday.[2] Over the one-year period, as much as about 2 million gallons of fuel may have been conserved as a result the auto travel diverted to bus. This is approximately equivalent to one and one half day's fuel consumption in the Denver region for all internal trips. It is estimated that about 1000 gallons of gasoline per weekday are conserved by retained free fare trips which would have been made by auto in 1979.

5.2 Impact on Area Work Scheduling Policies

An important indirect impact of the highly publicized off-peak free fare program might have been its effect on staggered work hours or flexi-time policies among area employers. Changes in personnel policies aimed at allowing transit using employees to take advantage of off-peak free fares, would also affect other employees' work trip routes, and perhaps result in reduced total peak hour vehicle travel. However, as a result of a number of implementation factors, the Denver off-peak free fare program does not appear to have served as such a catalyst.

During 1978, efforts were underway to achieve a policy of staggered working hours among the Denver Area's federal employers. Chief responsibility for the organized efforts resided with the Denver office of the Environmental Protection Agency and its Clean Air Task Force. Since federal employees in the Denver CBD number about 13,000, a shift in these commuters' work schedules could have a potentially large impact on off-peak transit rifership as well as CBD rush hour conditions in general.

This potential went unrealized during the period of the free fare program, however, for two primary reasons. Foremost was the difference between the two programs' objectives: RTD sought to increase the productivity of its existing off-peak services; the staggered work hour advocates sought to increase overall transit ridership by adding new travel options for the commuter. According to a survey conducted by EPA and Downtown Denver, Inc., there was a large potential market for additional "pre-peak" express service; that is, many commuters expressed a preference to travel between 6 and 7 a.m. Virtually no interest was shown in service after 8 a.m. The free fare demonstration, on the other hand, sought to increase the vehicle productivity of existing off-peak bus service. When the District changed the peak period from 7 to 9 a.m. to 6 to 8 a.m. and excluded all express service from the free fare, EPA contended that RTD removed whatever incentive may have existed for workers to adjust their travel times and it effectively penalized those who had already done so.

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[2] The national average for passenger cars in 1977 was 13.9 mpg. Motor Vehicle Manufacturers Association, "Motor Vehicle Facts and Figures '79."

5.3 Impact on CBD Revitalization

One argument for free fare is its potential for improving the vitality of the urban core and the central business district (CBD). A means of achieving this is through greater accessibility to the area with more attractive transit service. Two principal downtown revitalization objectives may be identified in the context of a free fare transit policy.

5.3.1 Retail Sales

Since free fare reduces the cost of travel to downtown, regional and transportation planners have argued that fare reduction could increase the number of CBD shoppers and thus improve business for retail merchants. It is estimated that the number of bus trips to Denver's CBD increased by nearly 25 percent due to the free fare demonstration -- about an additional 10,000 trips. However, the CBD's share of regional transit trips declined slightly from 48 percent to 46 percent. Also, most of the new bus trips to the CBD would have been made by other modes if there had been no free fare (based on responses to the on-board transit surveys).

Only the entirely new trips (induced) represent trips that would not have been made without free fare. Less than 10 percent of these new trips were made for shopping in the CBD -- no more than 500 on a typical weekday. This represents only a half percent increase in the number of shopping trips normally made to the CBD by all modes of travel. This is probably an upper limit estimate, since this slight increase appears to have been offset by prior bus users making relatively fewer CBD shopping trips due to free fare. Twenty-two percent (22%) of the Transit Follow-Up Survey (1/79) respondents stated that they made more trips to downtown because of free fares. However, more bus riders (25%) stated that they traveled less frequently to the CBD as a result of free fare.

Free fares not only encouraged bus users to travel to familiar shopping centers more often, but also to explore new shopping places. In fact, about 18 percent of the respondents report they took advantage of free fares to travel to destinations that they had not visited before free fares.

5.3.2 Vehicle Travel and Congestion in the CBD

The impact of free fares on the micro-environment of downtown Denver as a result of reduced auto traffic was only slightly greater than that of the impact on the region as a whole. Based on On-Board Survey (8/78) findings, as many as 7000 weekday auto trips to and from the CBD were diverted to off-peak bus trips. This represents about 2 percent of total estimated CBD auto trips. An impact of this magnitude probably may have had a small effect on reduced congestion, parking

demand or vehicle emissions. However, there may have been an important, largely symbolic effect, on public and official support for limitations on increasing downtown parking supply in the face of continued high parking demand.

5.4 Public Attitudes

A major question regarding the implementation of a free fare program was what would be the public's attitude toward the program and what effects would it have on general community support for transit? RTD, as a public agency concerned with maintaining public support and confidence, was specifically interested in determining the general public's attitudes and perceptions of the free bus service; e.g., whether or not the public viewed the program as a worthwhile experiment, and whether or not the public saw the use of local tax money to support the program as an appropriate expenditure. Furthermore, analysis might indicate the type of free fare program (i.e., who should ride for free and during what hours) that would receive strongest public support.

The opinions of both the general public and weekly transit users were measured in each of the three rounds of survey data collected in the evaluation. Most of the attitudinal reponses in this section have been taken from two surveys of randomly selected households conducted during free fare and third one taken after the termination of the program. (See Appendix A)

5.4.1 Attitudes Toward RTD

About one third of the Denver metropolitan households had no opinion about RTD during the demonstration; a somewhat smaller number had none afterwards.[3] About 55 percent of households with an opinion were satisfied with RTD service during 1978, about 62 percent of the sample in 1979. However, it is not clear whether RTD's public image actually improved over this time (as a result of having conducted and/or terminated free fare, implemented route restructuring, etc.) or if the difference is mostly a result of the higher proportion of transit users in the latter sample. Transit users were relatively satisfied with RTD during both periods; 57 percent during October 1978, and 60 percent May 1979.

[3]Opinions expressed in Round One (10/78) and Round Two (1/79), both during free fares were quite similar regarding free fares.

Table 5.1
OPINION OF BUS SERVICE IN GENERAL

Opinion of RTD Bus Service	During Free Fare		Post Free Fare	
	Transit[a] Users	General[b] Population	Transit[c] Users	General[d] Population
Very Satisfied	23%	13%	20%	19%
Somewhat Satisfied	34	24	40	26
Somewhat Dissatisfied	21	19	20	16
Very Dissatisfied	21	12	14	12
No Opinion	1	33	6	28
	100%	100%	100%	100%

Source: a) Transit User Follow-up (10/78)
b) Random Household Survey (10/78)
c) Transit User Follow-Up (5/79)
d) Random Household Survey (5/79)

5.4.2 Attitudes Toward Free Fare Program

As shown in Figure 5.1, almost all of Denver area residents were aware of the free fare program, a large majority favored the program, but less than a majority would support a tax to continue the program.

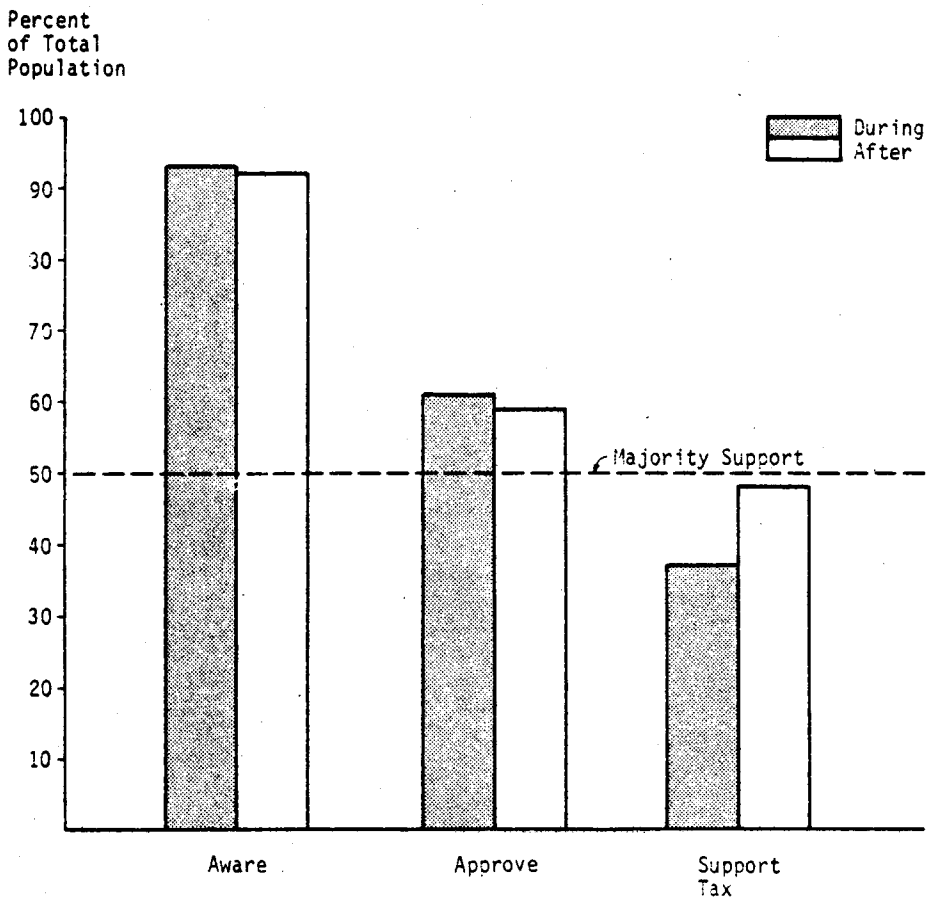
5.4.2.1 Awareness of Free Fares

Overwhelming proportions of the households sampled in each survey were aware of the free fare experiment; 93 percent in September, 90 percent in January, and 92 percent in May. While there are slight differences between surveys, the differences are not statistically significant. A sizeable majority of those who were aware of the program know of it indirectly rather than through direct use of the program. In fact, the May survey shows that of those who were aware of free fares, only 39 percent ever rode the buses for free. It is likely that many of the other 61 percent became aware of the program through the fairly extensive media coverage given to free fares.

5.4.2.2 Opinion of Free Fare Program

As shown in Table 5.2, positive evaluations of the free fare program were given by both the general population and regular transit users. However, while the general public appears to have maintained its strongly favorable attitudes toward the free fares (about 60% favorable), transit users appear to have become somewhat less favorable by the time the program was terminated (from 63% to 53% favorable). By May 1979, nearly half (45%) of transit riders were opposed to off-peak free fares.

Figure 5.1
SUPPORT FOR FREE FARE AMONG GENERAL PUBLIC: During and After Demonstration



Source: Random Household Surveys (10/78 and 5/79)

Table 5.2
ATTITUDES TOWARD FREE FARE PROGRAM

Opinion of Free Fare	During Free Fare		Post-Free Fare	
	Transit Users	General Population	Transit Users	General Population
Strongly Favor	41%	33%	31%	35%
Somewhat Favor	22	28	22	24
Somewhat Oppose	16	14	22	14
Strongly Oppose	17	12	23	12
No Response	4	11	3	15
	100%	100%	100%	100%

Source: (Same as Table 5.1)

Reasons among the general public for favoring the program were mostly related to perceptions that free fare encouraged ridership and allowed people to ride free (59% and 43% of those favorable). A smaller percentage of those with positive opinions believed it helped traffic congestion (22%); only a few thought it reduced air pollution (3%). On the other hand, among those households opposed to the program, about half indicated that they felt riders should pay a fare (41%) or that the program created an inequitable difference between peak and off-peak users (27%). Nearly half (48%) also reported that they were opposed because it allowed undesirable or unruly users to ride the bus who would not do so otherwise.

5.4.2.3 Attitudes Toward Continuing Free Fare

Although there was opposition to the off-peak free fare program as implemented most respondents thought that free fares should be continued in one form or another. Of the 90 percent of respondents who had an opinion, only about 5 percent in each survey felt that free fares should be totally discontinued. A majority of those who expressed an opinion in each round thought that free fare should be either expanded to all hours or continued during the off-peak hours. However, the percentage of those wanting to continue the program as implemented declined from 29 percent in September to 21 percent. At the same time, the proportion in favor of limiting future free fares to one or more needy groups (i.e., the elderly, handicapped, poor, or young) grew, from 30 percent in September to 40 percent in May. When asked specifically if free fares should be continued for needy groups after the program was ended, an overwhelming majority of those answering in each survey felt that the elderly and handicapped should continue to ride for free (83% to 90%). Attitudes toward continuing free fares for low income people appear to have increased with time -- from 41 percent to 53 percent. About 30 percent of respondents felt that all youths (16 and under) should ride for free. In general, Table 5.3 figures indicate a shift in attitudes toward a limited free fare program. None of the surveys showed a majority in favor of providing free fares to everyone during all operating hours.

Table 5.3
ATTITUDES TOWARD CONTINUING FREE FARES

Program Type	During Free Fare		After Free Fare
	September	January	May
Expand to all Hours	36%	37%	36%
Continue during Off-Peak	29	25	21
Limit to Needy	30	34	40
Totally Discontinue	5	4	4
	100%	100%	100%

Source: Random Household Surveys

If free fares were retained, local funds would probably have been required for the share of the program's cost no longer supported by federal grants. The cost per household would vary according to the nature of the program, but a rough estimate of the cost, as described for the respondent, was from $10 to $20 per year.

Opposition towards paying this $10 to $20 in annual taxes decreased with time. During the program, a majority of those who gave an answer opposed the tax, but by January that majority apparently had decreased from 59 percent to 52 percent. After the end of free fare, it appears that a majority of those who were aware of the free fare program and had an opinion (89%) favored the tax (54% in May). Despite this indication of support, there was never a clear majority of the total sample which supported the tax (48% in May).

As a whole, the three surveys indicate that while support for a tax to support free fare increased with time, the majority of the total public did not support the tax. Those who are currently unaware of the free fare experiment or have not formulated an opinion can play a pivotal role in determining the outcome of any public plebiscite on using local taxes to support free fares.

Table 5.4
ATTITUDES TOWARD LOCAL TAX TO CONTINUE FREE FARE

Opinion	During Free Fare		After Free Fare
	September	January	May
Strongly Favor	9%	11%	17%
Somewhat Favor	28%	30	31
Somewhat Oppose	19	17	16
Strongly Oppose	34	28	25
Unaware/No Opinion	10	14	25
	100%	100%	100%

Source: Random Household Surveys

The level of support for a tax to fund free fare is surprising given the recent expressions of an anti-tax mood in the nation. The total local tax burden in the Denver Metropolitan Area is generally comparable to that of most major urban areas. The opinion surveys conducted for this evaluation seem to indicate a strong public concern for better transit even if additional taxes are required. In fact, only 15 percent of the May sample left that no additional taxes should be levied for transit improvements.

More respondents than those supporting a free fare tax (in fact a majority) favored the development of a rapid rail system (59%) and/or the purchase of more buses (52%). The predilection for expenditure on rapid rail appears to stem from the expectation that future public transit in Denver will be provided by a mixture of bus and rail. Fifty-five percent (55%) of the sample in May 1979, felt that RTD should be developing both a bus and rail system to serve the public twenty years hence.

6.0 SUMMARY AND CONCLUSIONS

The purpose of this final section of the report is to summarize the major findings of the Denver, Colorado off-peak free fare transit demonstration program. Conclusions drawn from the study of free fare transit in Denver are presented in light of three general criteria for policy evaluation.

- Effectiveness. To what degree did the program fulfill the various objectives established for it or general expectations for free fare transit?

- Efficiency. Did free fare during the off-peak hours represent an efficient use of transportation funds? Did benefits outweigh costs? Did it promote greater transit productivity than other strategies to increase bus ridership?

- Equity. Were program benefits and costs equitably distributed? Were free fare effects more progressive than transit service which is at least partially supported by user charges, i.e., a greater share of service consumed by the neediest.

In addition to addressing these questions, an overview of free fare as a transit marketing tool is provided, based on an analysis of the key program characteristics of the Denver demonstration which could be varied in other applications of the free fare concept.

6.1 Transferability of Findings

A major objective of the evaluation is to provide findings which are of general value to other areas and to national transit policy. Results of the Denver free fare program however, are of greatest relevance to metropolitan areas which share common demographic and travel characteristics. The important aspects of the Denver setting which are noteworthy include:[1]

- Auto-dominance: Only 7 percent of households own no vehicle compared to the 17 percent national average for metropolitan areas.[2] The Denver metropolitan area is a relatively low-density region with a diffusion of activity centers not easy to serve effectively with public transit.

- Transit Service Characteristics: The Denver RTD operates an extensive transit system which provides a relatively high level of service for a clientele that is mainly transit

[1] In many respects the Denver free fare program setting contrasts with that of the other free fare demonstration funded by UMTA during 1978. See De Leuw, Cather & Company, Trenton Off-Peak Free Fare Experiment, Interim Report. UMTA/TSC Project Evaluation Series, October 1978.

[2] U.S. Bureau of Census, "Selected Characteristics of Travel to Work in 20 Metropolitan Areas" 1976.

captive. Consequently, performance indicators (passengers per mile, fare revenues as percent of costs, etc.) are generally lower than the national average.[3] Fare levels are moderate and provide revenues which cover about one third of operating costs. The one-half cent transit district sales tax is a somewhat distinctive feature of the Denver situation.

- Institutional Context: Since Denver is the State Capitol, the operation of transit is in more political light than is likely to be the case elsewhere.

6.2 Value of Off-Peak Free Fare as General Transportation Policy

The free fare demonstration in Denver was conducted for an entire year, providing sufficient time to evaluate free fare as a long-term public transportation policy. A high degree of subsidization for transit operations has become an established element of transportation policy. The question remained whether or not complete subsidization, of at least off-peak transit service, may be a desirable element of general policy.

6.2.1 Effectiveness

The effectiveness of off-peak free fare may be judged in four areas of impacts in the Denver experiment -- implementation process, travel effects, operational and financial impacts, and indirect effects.

6.2.1.1 Implementation Process

The principal conclusion regarding the implementation process of off-peak free fare program is that substantial planning and allocation of marketing resources are needed to minimize certain problems inherent in a complex program of this kind. Due to a number of factors mostly related to the timing of the free fare experiment during a period of many competing demands on RTD resources, some problems experienced were more severe and difficult to deal with effectively than they may have been without such limitations.

The free fare demonstration evolved from a period of uncertainty during the Spring of 1978 when the locally initiated "Transit Awareness Month" was extended several times prior to local and federal agreement on its ultimate fate as a one year demonstration project. RTD had just implemented a new fare structure in January. Also during this time, a large shipment of new motor coaches was being received and absorbed into service. Substantial increases in service as part of the March run-board changes were also made, along with the route restructuring changes implemented in Boulder and the Northeast section of Denver during that same month. In addition, RTD staff was preparing for the comprehensive route changes that were planned for September 1978.

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[3] American Public Transit Association, "Transit Fact Book," 1978.

The implications of severe limitations in lead time, staff and budgetary resources and institutional mechanisms to plan, implement and respond to project events were illustrated by the Denver demonstration. The sponsors' ability to communicate program objectives and to respond to public reaction were constrained, contributing to subsequent problems and demands on limited resources. The lack of direct mechanisms for active public input into program decision-making left key issues of this highly visible public project to be debated in the press. Public misunderstanding of free fare's objectives persisted, tending to crystallize around the program's negative aspects, the more sensational of which were broadcast by the media. Detractors continued to question the program's basic organization, while particular groups perceived themselves to be arbitrarily or unfairly affected by free fares.

Public participation mechanisms may have helped to avoid particular problems. Earlier efforts to involve students, for example, may have circumvented the vandalism. Responses to the survey of RTD drivers conducted as part of this evaluation indicate that drivers resented what they saw as their exclusion from free fare planning. This resentment apparently contributed to their frustration over the operational difficulties associated with the program.

Limitations in staff time and budgetary resources also precluded extensive coordination between the free fare program and other local transit-related efforts, such as the federal employee flextime program. RTD attempted to provide marketing materials to downtown businesses, urging shoppers to use the bus during the free off-peak period, but no full-scale, coordinated promotion was possible.

On the other hand, the effectiveness of RTD's promotion of monthly passes and tokens in conjunction with the reinstatement of fares demonstrates the potential for widescale coordination and success which exists when there are resources to take advantage of it. RTD had ample lead time to plan for the termination of free fares, to adopt a public policy position on fare reinstatement and to market its money-saving options in cooperation with local retailers.

Applying the experience of the Denver program's implementation to other areas where demonstrations of similar innovative nature may be tried, suggests that appropriate funds be allocated to provide specifically for project planning and implementation staff and mechanisms, apart from ordinary transit operating functions. An extension of this conclusion, moreover, suggests that innovative public involvement and program implementation mechanisms are in themselves an appropriate focus of demonstration support.

6.2.1.2 Travel Demand Effects

Off-peak free fares provided a sufficient incentive for a dramatic increase in bus trips made in the Denver metropolitan area. Elimination of the 25 cent off-peak fare resulted in about a 32

percent increase in total weekly bus trips. As a result, RTD served about 34.3 million trips during the demonstration; 8.2 million more than would have been made by bus had there been no free fare program.

Nearly 70 percent of bus trips made during the year were during the no fare periods -- weekday off-peak (all times other than 6-8 a.m. or 4-6 p.m.) and all day Saturday and Sunday. Ridership during these times was about 52 percent higher than projected base ridership. Weekday off-peak ridership increased from about 52,000 to about 78,000 trips; the impact on weekday peak ridership of about 40,000 appears to have been negligible, perhaps even a slight increase due to spill-over effects and improved service quality. Saturday increases were comparable to off-peak weekday gains -- about 50 percent increase -- but Sunday ridership increases were relatively greater -- about 100 percent. Similarily, the effect of off-peak fare elimination appears to have been somewhat greater for the circulator type service provided in Boulder, than for regular route service operated in Denver.

Ridership increases occurred quite rapidly in the beginning of the program -- about 85 percent of total gain in the first month. Ridership gains were greatest during the summer months due to a higher level of discretionary trip-making. All else being equal, it appears that maximum ridership impacts were achieved within about three or four months after the program's inception.

Long-term ridership gains due to the program, however, appear to be much more modest than those experienced during the demonstration. New ridership due to free fare dropped off rapidly after the program ended -- from about 30 percent retention the first month, to about 15 percent four months after the program. This may be seen as the maximum long-term effect; it represents about 4,000 additional daily trips or about 4 percent of total post-free fare ridership.

Free fare appears to have been somewhat less effective in expanding the transit market (population of bus users) than in increasing total bus travel (bus trips). It is estimated that about 10 percent of the new bus trips due to free fare were made by new riders -- persons who would not have begun using RTD without the no-fare incentive. About half of these new riders predicted they would continue to use the bus when fares where reinstated, a smaller percentage than prior riders. The transit user population (one bus trip a week or more) increased during the demonstration from about 7 percent to 10 percent of the metropolitan population.

The free fare program was effective in expanding the travel options of those who switched from other modes, about one-half of new bus trips, and in increasing the mobility of those who made entirely new (induced) trips, about one-sixth of new bus trips. The socio-economic characteristics of transit users however did not change substantially, despite somewhat greater increases in bus tripmaking by upper-income households, younger persons, and minorities. The composition of off-peak ridership remained much the same as before the program.

Off-peak ridership continued to be comprised of considerably more transit dependent persons than peak hour ridership, and there were considerably more transit dependent persons in peak-hour ridership than either before or during the demonstration.

There were more discretionary trips made during the free-fare off-peak periods (only one-third work trips) than during full fare peak periods, but there was little difference in discretionary travel during free fare and reduced fare off-peak periods. The greatest growth in bus travel was for social-recreational and non-home based travel. A substantial but indeterminate number of very short trips were apparently made previously by walking. The average length of other free fare trips was apparently only a little less than fare paying off-peak bus trips. More people traveled downtown during the free fare period, but the proportion of downtown free fare travel was actually somewhat lower than prior off-peak bus travel.

While the net effect was a substantial increase in transit trips served by RTD, there appears to have been a significant number of prior riders who reduced their bus use as a result of the negative effects of increased off-peak passenger loadings on the quality of bus service (see discussion below). Some previous off-peak users switched to the peak (about 7%); some shifted to other modes or discontinued the trip (about 4%), others were indifferent to the deterioration of service or unable to change their bus travel routines.

6.2.1.3 Transportation Supply and Costs

The increase in off-peak transit ridership was achieved with only a minimal increase in off-peak bus operations -- about 1 percent of total operating costs, hours and miles. Additional service was implemented on only the few routes with the highest patronage. The majority of off-peak bus runs experienced a substantial increase in vehicle utilization without major over-loadings. However, operational problems occurred considerably more often than before the program and often approached peak hour levels.

Service levels and the on-board environment deteriorated mostly because of increased passenger volumes, but also as a result of more frequent use by rowdy youths, and other "undesirable" riders who were perceived as threatening to many RTD users. The lack of available seating, schedule adherence problems, and diminished personal security were the most common complaints of bus riders during the program.

The free fare program was relatively effective in promoting a more efficient use of RTD's vehicle fleet. The dramatic ridership gains were achieved with only a small impact on operating requirements. System performance indicators, such as passengers per mile, per hour, or per dollar improved greatly and approached those of peak hour operations. However, maintenance requirements increased as a

result of vandalism by free fare users. Driver's performance, morale and courtesy were negatively affected. A small increase in bus accidents occurred early in the program, and drivers became actively opposed to the program after several months.

The total financial impact of the off-peak fare elimination was about a 2 percent increase in RTD's annual operating expenditures and about a 42 percent revenue loss. Combined, the total budget impact of additional costs and fare revenue losses was about $4.8 million for the one year program; half of this was funded with local sales tax revenues. This represents only about 6 percent of RTD's $38.3 million annual operating budget. Primarily due to the free fare program, the total operating subsidy increased from about 73 cents to 85 cents per dollar spent on transit service during the one year period of the demonstration. But the increased ridership due to free fare kept the subsidy per passenger about the same (82 cents). No long-term impacts on RTD's service requirements or operating costs are currently evident. Long-term ridership effects generated some additional fare-revenues after the demonstration; about 15 or 30 percent of revenue loss during the demonstration may be ultimately recovered due to ridership increases attributable to the free fare program.

6.2.1.4 Indirect Effects

The secondary impacts of the free fare program were quite small. While transit ridership increased substantially, the total proportion of area travel affected was minimal -- about one-half of one percent. Reduction in vehicle miles of travel, improved air quality, and energy conservation effects were resultingly small. In general, a free fare transit program by itself appears not to be a very effective strategy to improve urban area environmental quality. It is also clear that special efforts will be required in order for an off-peak fare incentive program to have a significant impact on such programs as changes in the work scheduling policies of area employers which might have greater area effects.

On the other hand, free fare does appear to effectively generate increased general public awareness and support for transit. In fact, the general public was more favorable about the free fare program than regular transit users. While somewhat less than a majority of area residents would support a tax for continued free fares, the RTD public image was high both during and after the program. Nearly 85 percent of the public were willing to support new taxes for transit improvements after the program; about 60 percent to develop a rapid rail system and/or purchase and put more buses into operation.

6.2.2 Economic Efficiency

One important measure of a publicly funded program is the extent to which it promotes economic efficiency. The most common evaluation measure is the benefit-cost ratio, which attempts to address the question of whether or not the returns from a program outweigh the

investment or expenditure. The limitations of cost-benefit analysis are well-known, and its application, particularly in the context of non-capital investment social programs, must be viewed with caution. Consequently, the cost-benefit analysis conducted in the Denver free fare evaluation is supplemented by two other analyses which are also indicators of economic efficiency. The first focuses on the output (gross ridership increase) gained from the expenditure. It also incorporates the concept of opportunity costs, i.e., whether or not the money would have been better spent on other transit programs, in particular on improved service. The second focuses on the question of optimal pricing; the underlying economic notion is that marginal revenues should at least equal marginal costs. In other words, fares should be set at the cost of providing the last bus trip purchased.

6.2.2.1 Output: Gross Ridership Changes

Is a free fare program a cost-effective means of increasing ridership? As discussed in Section 3.5, transit demand in Denver was relatively insensitive (inelastic) to changes in price. It took a 100 percent decrease in off-peak and weekend fares to induce a 50 percent increase in ridership during these periods.

Do these findings indicate that free fare is not a desirable approach to increasing transit use? More specifically, would the $4.7 million dollars required for the one-year program have been more productively spent on improved service? Transportation studies typically show that the absolute value of service elasticity is consistently greater than the absolute value of price elasticity.[4] In other words, a one percent improvement in service (e.g., by expanding service miles by one percent) induces a greater response than a one percent decrease in price. At first glance, improving service appears to be a better strategy than free fare.

However, the direct comparision of price and service elasticities is inappropriate because of incompatible units (miles and dollars). The free fare experiment provides an indication of whether an equivalent expenditure to improve service would have increased ridership more than eliminating off-peak fares. The Denver demonstration suggests that fare reductions are more productive in terms of gross ridership increases. The $4.7 million free fare program expenditure generated a net increase of 8.2 million person trips during the year long project. If the money had been used to expand service, it is optimistically estimated that the increase in ridership would have been

[4] Peat, Marwick, Mitchell, and Co., 1979; Pratt, Pedersen, and Mather, 1979.

somewhere in the range of 3.1 million to 4.2 million annual bus trips.[5] This implies that for every one dollar invested in new service (operating costs and annualized additional capital costs) about .67 to .86 additional trips would be generated. The same dollar invested to eliminate off-peak fares generated approximately 1.69 new bus trips. The free fare strategy therefore appears to be about twice as "productive" per dollar spent in terms of absolute numbers of new bus trips made.

However, this analysis does not answer the difficult policy question whether it is better to use new funds available to transit to increase subsidies or to expand service. The one year demonstration in Denver points to the conclusion that for a given dollar spent, short-run increases in gross ridership may be greater with the elimination of fares than with the provision of additional service, particularly if service levels and market penetration are already relatively high. However, despite the low estimates of immediate impact on gross ridership levels, improving services through expansion may be a better long-term strategy in light of the full range of transit goals of policy-makers. While excess capacity may be created in the short-run, the extra capacity will be needed if future demand for public transit continues to increase about energy availability.

6.2.2.2 Marginal Costs and Revenues

Basic micro-economic theory dictates that the optimal allocation of society's resources occurs when the price paid for a commodity or service is equal to the cost to produce the last unit of that good. If the prevailing price exceeds the marginal cost, then too little is being produced. Lowering the price not only brings the price closer to marginal cost, but also stimulates more consumption and production. If the prevailing price is less than the marginal cost, then too much is being produced. The solution in this case is to raise the price to dampen consumption and production.

By this pricing criterion, most transit agencies have off-peak fares which are too high. Because there is excess bus capacity during the non-rush hours, it cost nothing in additional resources to provide an additional trip, i.e., the marginal cost for that trip is zero. This observation has become a standard argument for eliminating fares during non-peak hours. Findings from the Denver experiment do not entirely support this argument.

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[5] This is based on the assumptions that service elasticity is equal to +.6, that the total investment is equal to $4.9 million (including the increase in revenues from new trips), that at the margin a one percent investment increases service by one-and-a-half to two percent, and no additional capital costs. If the funds were solely used to improve off-peak service, the impact would probably be somewhat less.

While the actual cost of providing the last additional trip because of free fare is not known, it is possible to calculate the additional cost to the agency per new trip (total cost of additional resources divided by the total number of new trips). If the marginal cost were truly zero, then the additional cost per new trip would be zero. However, this was not the case in the Denver free fare demonstration. Along routes where demand did not exceed the pre-existing capacity, the additional cost to the transit agency was quite small -- about $.04 per new trip. Along a few heavily used routes, the additional cost was much higher -- about $.16 per new trip. For these routes the marginal cost per providing the first few additional trips might have been zero, but as demand exceeded capacity, marginal costs increased noticeably.[6]

Not only was RTD's marginal cost greater than zero, but the total marginal cost to society was probably higher. Total marginal cost must also include externalities borne by transit users who were more likely to find themselves on crowded buses and with rowdy teenagers or derelicts due to free fare ridership increases. Consequently, the total marginal cost may have been substantially higher than the cost to the transit agency.

While the above economic analysis indicates that no fare is not the "optimal" price for off-peak transit, it suggests that 25 cents was probably too high on the margin since the average additional cost of providing all new trips was only about 9 cents. This average cost is not necessarily the "optimal" fare; it does suggest, however, that reducing rather than eliminating fares would result in a price for off-peak transit service closer to the optimum. The constraints, of course, are the limits of existing capacity, the possibility of increased on-board discomfort and security risks, and the inability or unwillingness of the agency to cover the difference between the real total cost and the "optimal" marginal cost.

6.2.2.3 Benefit Cost Ratio

Another method drawn from economic analysis of evaluating the value of free transit is to compare benefits and costs. Benefits include the direct fare savings accrued by users and any indirect effects enjoyed by users and non-users. However, in Denver the indirect benefits were small and may be omitted from the analysis without significant loss of accuracy.

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[6] Estimates based on $.40 million for extra service on four routes (and trippers) with about 45 percent of free fare ridership gain. All other program costs (administrative, planning, monitoring, marketing, etc., $.37 million) allocated to all routes uniformly.

Normally, the direct benefits of free fare is measured by calculating the change in consumer surplus in response solely to a change in price.[7] This provides an upper estimate of the benefit to cost ratio. Using this approach the total fare savings was between $5.1 million and $5.2 million, depending upon the shape of the demand curve assumed, compared to total program cost of about $4.7 million. The simple benefit-to-cost ratio is derived therefore between 1.08 and 1.10.

This method, however, clearly over-estimates net benefits, since it includes only fare savings and does not incorporate quantification of the adverse impacts on quality of service due to the demonstration project. For a lower level of service, users are not as willing to pay as much per transit trip. Consequently, the size of the consumer surplus was smaller than it would have been if there had been no changes in the quality of service. Considering the impact of lower service, a best case estimate of the dollarizeable benefit is between $4.4 million and $4.7 million.[8] The quantifiable benefit is cost ratios would be less than one, suggesting that free fare is an undesirable project by this measure.

Because the results are not robust, i.e., the estimated ratios are not consistently much greater or less than one, the analysis suggests that free fare is at best a marginally worthwhile program according to benefit-cost criterion. And when these results are combined with those of the two preceding evaluations, it appears that free fare may be desirable only as a short-term project, provided that it attracts and retains new transit riders.

6.2.3 Equity

Compared to the criteria for economic efficiency, the concept of equity is inherently more normative and subjective. Nonetheless, there are two widely accepted standard measures of equity in economics -- progressive redistribution and horizontal equity. Progressive redistribution (or vertical equity) refers to a distribution of benefits which favors the less affluent and/or to a tax system which places a greater burden upon the more affluent. This is the concept

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[7] Consumer surplus fare savings incorporates the idea that many free fare off-peak trips would have been made if the cost were $.25. Consequently the average value of free fare trips to free fare users is less -- about $.18.

[8] Based on the following assumption; average fare savings for those adversely affected but still using off-peak service is $.125; and for those who switched to other service or time, a loss of $.10 per trip. Again an exponential and a linear curve are used to estimate the demand curve.

incorporated in the U.S. income tax schedule. The opposite pattern, which is common to taxes on retail sales or property taxes, is said to be regressive. Horizontal equity means that persons or households of equal circumstances should face the same balance of benefit and burden. Two households are said to be of equal circumstances if they have the same annual income. Although the test for horizontal equity is normally used to examine tax incidences or public expenditure separately, for the purpose of this evaluation horizontal equity is analyzed in terms of net outcome (benefits minus tax burden).

The distribution of benefits under free fare was progressive due to the fact that lower income groups shared in fare savings to a greater extent than upper income groups. However, the incidence of burden for the local costs ($2.4 million) was regressive due to the use of sales tax revenues. Strong horizontal inequities also existed between infrequent and frequent users as is typical of many public transportation programs in which less than the entire population enjoys direct (or substantial indirect) benefits.

6.2.3.1 Vertical Equity of Benefits

The key to analyzing the degree of vertical equity of free fare is the distribution of benefits among income groups. Here benefits are equivalent to subsidies, and this provides a measure of the portion of the program's output received by each group. The distribution is said to be progressive if lower income groups received a share of the benefits that was larger than their portion of all households in the region.

Because low income people made a disproportionately larger share of the non-peak hour trips, they received a disproportionately larger share of the subsidies. This remains true even after the allocation of subsidies is adjusted for the fact that on the average, costs of transporting higher income users was slightly higher as a result of longer bus trips.[9] The progressive distribution of benefits is revealed in Table 6.1, which shows the distribution of subsidies on typical weekday. While low income households with less than $10,000 annual income comprised about 33 percent of the general population, they received about 47 percent of the subsidies. On the other hand, high-income households ($25,000 or more) comprised 19 percent of the population but received only 16 percent of the benefits (see Table 6.1).

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[9]The adjustment is made by weighting the trips by factors that reflect the differences in average trip lengths, based on analysis of a geo-encoded origins and destinations of On-Board Survey (8/78) respondents.

Table 6.1
DISTRIBUTION OF SUBSIDIES AMONG INCOME GROUPS

Income Group	With Free Fare Peak	With Free Fare Off-Peak	Without Free Fare Off-Peak	Percent of DMA Households
Under $5,000	8	23	22	15
$ 5,000 to $9,999	19	24	26	18
$10,000 to $14,999	18	18	17	19
$15,000 to $24,999	23	20	20	29
More than $25,000	27	16	15	19
	100%	100%	100%	100%

Source: DCCO estimates adjusted for variations in trip distances.

While free fare was a progressive program, the distribtuion of off-peak subsidies was not noticeably different from the distribution if the scheduled fares had been levied. The free fare program provided a slightly smaller share of the subsidies to the poor (47% with free fare compared to 48% without) and a slightly larger share to the wealthy (16% with free fare compared to 15% without). The major difference is in the absolute amount of subsidy distributed. Under free fare, subsidies to each group increased by approximately 27 percent. Because peak-hour service is oriented towards a higher income group, the distribution of total subsidies on a typical weekday is less progressive than the distribution for off-peak service. Without the demonstration project, the distribution of total weekday subsidies would have been nearly the same. In either case, low income users would have received about 40 percent of the subsidy.

6.2.3.2 Horizontal Inequities

While there was a progressive distribution of subsidies during free fare, income transfers were not simply between economic groups. Much larger income transfers occurred between users and non-users regardless of income. The income redistribution effects of the provision and funding of RTD transit and the free fare program are illustrated for "typical" low and high income households in Table 6.2.

Net gainers were differentiated from net losers by the number of free fare trips made during the program. The free fare program resulted in a sizable minority of the population receiving substantial fare savings (net gainers) while a majority were net losers, but of only a small absolute dollar amount. With an estimated

Table 6.2
ANNUAL TRANSIT BENEFITS AND TAX BURDENS DURING DEMONSTRATION ON TWO "TYPICAL" HOUSEHOLDS

	A	B	C	D
	FF Fare Savings	FF Sales Taxes	Total Subsidy	Total RTD Sales Taxes
Household A				
3 Members w/$10,000				
No Transit Trips	$ .00	$1.76	$ 9.00	$30.00
1 Free Trip per Month	2.16	1.76	9.60	30.00
1 Free Trip per Week	9.36	1.76	41.60	30.00
3 Free Trips per Week	28.08	1.76	124.72	30.00
Household B				
3 Members w/$30,000				
No Transit Trips	$ .00	$2.42	$ .00	$41.34
1 Free Trip per Month	2.16	2.42	12.38	41.34
1 Free Trip per Week	9.36	2.42	53.66	41.34
3 Free Trips per Week	28.08	2.42	160.97	41.34

NOTES:

A. Equivalent to Consumer Surplus and equals $.18 per trip. This is a high estimate.

B. 5.86 percent of Column D. Based on the fact that the local share of the free fare project, about $2.4m, comprised 5.86 percent of the total sales taxes collected.

C. The difference between the two households reflects the longer trips usually taken by riders from higher income households.

D. These estimates assume no forward passing of sales taxes paid by businesses on non-consumer items. Estimates of local sales tax derived from federal tax deduction tables have been adjusted upward and account for an assumed higher proportion of disposable income spent by lower income households on consumer goods subject to local sales taxes.

54 percent of RTD's sales tax revenues derived from individual resident retail purchases, tax incidence of the program costs was an average of about $2.40 per household. Total RTD sales tax revenues during the demonstration amounted to about $40 per household. If a three member household with $10,000 in annual income made at least one off-peak trip per month, it was able to recover its tax contribution towards the free fare program. Even among the more affluent, occasional use of free transit enabled the household to recover its share of the tax burden. A three member household with $30,000 in annual income needed to make as few as two trips per month to recover its taxes.

Net losers constituted about one half of the low-income households (less than $10,000 a year), two-thirds of the middle-income households ($10,000 to $24,999), and three-quarters of the high-income households ($25,000 or more). An obvious and expected pattern is that the proportion of net losers would increase with income since the more affluent travelers used public transit less frequently if at all. However, horizontal inequity was prevalent even within the low-income group - over one-half of households under $5,000 were net losers.

The greatest relative burden of the free fare program fell on low income households that did not use the transit system at all.[10] These households comprised about 45 percent of all low income households. This results directly from the fact that sales tax revenues were used to finance the local share of the demonstration project. Under such a taxation, the relative burden on a $6,000 household is twice as great as on a $25,000 household. Where sales tax revenues are the only feasible source of transit program local funding, regressivity may be mitigated by application of the tax to non-essenial goods.

6.3 Value of Free Fare as Transit Marketing Strategy

It appears that while free fare may not be a desirable permanent element of transit policy, it can be an effective marketing strategy to increase transit use and to introduce new riders to public transportation. The Denver experience shows that with a relatively small commitment of resources and a modest total impact on a transit agency's budget, major ridership gains can be achieved. While retained ridership may be less than originally expected, post-free fare ridership was significantly higher than it would have been without the program, and public support for transit remained strong if not improved.

6.4 Future Research

Certain questions arise in the form of working hypotheses for additional research. These relate to those aspects of the Denver free

[10] Relative burden is the percentage of total household income paid in taxes.

fare program which might be altered in other locations so as to enhance the efficiency of marketing applications of the limited free fare concept. Those of special interest are listed below:

- Would a longer lead time, more planning, and broader participation improve the implementation process? It appears so particularly in terms of improved definition and communication of program objectives to the general public and to potential and current bus users.

- Would a shorter program, with proportionately lower costs accomplish a comparable ridership growth while minimizing sustained negative service quality impacts? This also seems likely since maximum ridership gains were achieved within the first few months, but transit user perception of service level deterioration increased over the one year program. If a two month program in Denver could have achieved three-quarters of the long-term ridership retention effects of the one year program as seems possible, it is estimated that the revenue loss incurred might be recovered in about five years -- a one month program in about two to three years.

- What would be the effect of a more limited off-peak free fare period? The negative operational impacts of overcrowding and poor schedule reliability occurred right around the peak hours as a result of peak hour riders adjusting their travel schedules. Peak hour service conditions, however, did not appear to have been significantly improved. A program with a more limited off-peak time frame during those times of the day with the lowest average vehicle productivity might minimize operational problems and revenue loss, but still have both a strong public relations value and positive ridership effects.

- Would the marketing effectiveness of a free fare promotion be enhanced by commitment of sufficient additional bus service to maintain an attractive level of service? There is no question that service related attributes are the principal barriers to transit use for a large share of the general public who never or rarely use the bus system in Denver. While transit services probably cannot be operated to compete in a cost-effective manner with the convenience of the automobile for most trips, an objective of any marketing effort should be to put transit's best foot foward. The elimination of a relatively low fare, combined with overcrowding, late runs and security problems does not appear to be a very effective way to attract a sizable number of new bus users. With a shorter and more limited program, it may be possible to maintain desirable service levels without overtaxing labor, equipment and budget resources.

The Denver demonstration indicates that free fare transit is far less than a panacea for urban transportation and environmental problems. Reduced fare transit is one option within a balanced and effective transportation policy that deserves continued interest and support. The primary value of free fare transit is probably as a short-term marketing strategy or as temporary promotional adjunct to the initiation of transit service improvements.

BIBLIOGRAPHY

Abrams, Robert. "No More Tokenism--The Case for Free Subways and Buses." New York, 4, No. 32, pp. 24-29. 1971.

Aleshire, Robert A. "Sure the Cost Would Be High: But Offsetting Economic, Social, and Environmental Benefits Abount." Nation's Cities, 9, No. 12, pp. 25-28. 1971.

Aleshire, Robert A. "The Case for Free Transit." Current, 135, pp. 19-22. 1971.

Amalgamated Transit Union. "A Solution: No-Fare Transit." In Transit, 83, No. 10 (special section).

Bates, J. W. "Effect of Fare Reduction on Transit Ridership in the Atlanta Region; Summary of Transit Passenger Data." Transportation Research Record, No. 499. 1974.

Batty, M.; P. G. Hall and D. N. M. Starkie. "The Impact of Fares-Free Public Transport Upon Urban Residential Location." Proceedings of the Transportation Research Forum. Oxford, Indiana. Richard B. Cross Company, 15, pp. 347-353. 1974.

Baum, Herbert J. "Free Public Transport." Journal of Transport Economics and Policy, 7, pp. 3-19. 1973.

Brosch, David Charles. "The Rationale for and the Establishment of a No-Fare Mass Transit System in the Washington Metropolitan Area." (unpublished student paper) Washington, D.C. Howard University. 1975.

Caruolo, John B. and Robert P. Roess. "The Effect of Fare Reductions on Public Transit Ridership." New York, New York: Polytechnic Institute of New York. 1974.

Charles River Associates, Inc. "An Evaluation of Free Transit Service." Report 125-1, Cambridge, Massachusetts: Charles River Associates, Inc. 1968.

Daly, A. J., K. G. Rogers and A. W. Whitebread. "Estimating the Use of Free Bus Passes in Reading. Report C174, Reading, UK: Local Government Operational Research Unit. 1973.

De Leuw, Cather & Company. Evaluation Plan for the Denver Free Fare Demonstration and Route Restructuring Project. UMTA/TSC Project Evaluation Series. October 1978.

De Leuw, Cather & Company. Evaluation Plan for the Trenton Free Fare Demonstration Project. UMTA/TSC Project Evaluation Series. February 1978.

De Leuw, Cather & Company. Trenton Off-Peak Free Fare Public Transit Experiment. UMTA/TSC Project Evaluation Series: Interim Report No. UMTA NJ-52-0001-79-1. January 1979.

De Leuw, Cather & Company. Denver Off-Peak Free Fare Public Transit Experiment. UMTA/TSC Project Evaluation Series: Interim Report No. UMTA-CO-06-0010-79-1. May 1979.

Dillion, Robert W. and John A. Bailey. "Legal and Political Aspects of Free Transit in Major Metropolitan Areas." Evanston, Illinois: Northwestern University Transportation Center. 1970.

Domencich, Thomas A. and Gerald Kraft. Free Transit. Lexington, Massachusetts: D. C. Heath and Company, 1970.

Donnelly, E. P. "Preference Elasticities for Transit Fare Increases and Decreases by Demographic Groups." Transportation Research Record 589. 1976.

Dueker, K. J. and J. Stoner. "Examination of Improved Transit Service." Highway Research Record, No. 419. 1972.

Dygert, P.; J. Holec; and D. Hill, Public Transportation Fare Policy. Washington, D.C.: Peat, Marwick, Mitchell & Co. 1977.

Elliott, John M. "No-Fare: Key to the Transit Jam." American Federationist, 79, No. 8, pp. 9-15. 1972.

Goodman, Keith M. and Green, Melinda A. Low Fare and Fare-Free Transit: Some Recent Applications by U. S. Transit Systems. UMTA-DC-52-0002-77-1, by the Urban Institute for the Urban Mass Transportation Administration. February 1977.

Goodwin, P. B. "Some Data on the Effects of Free Public Transport." Transportation Planning and Technology, 1, pp. 159-174. 1973.

Greenspan, H. P. "The Case for Prepaid Transit." Transit Journal, 1, No. 1, pp. 57-63. 1975.

Grey, Alexander. Urban Fares Policy. Saxon House, D.C. 1975.

Holland, D. K. A Review of Reports Relating to the Effect of Fare and Service Changes in Metropolitan Public Transportation Systems. Washington, D.C.: U. S. Department of Transportation. June 1974.

Horowitz, Joel and S. Kuhrtz. Transportation Controls to Reduce Automobile Use and Improve Air Quality in Cities. U. S. Environmental Protection Agency Washington, D.C. November 1974.

Kemp, Michael A. "Reduced Fare and Fare-Free Urban Transit Services--Some Case Studies." UK Transport and Road Research Laboratory, pp. 37-54. 1974.

Kraft, Gerald. "Free Transit Revisited." Public Policy, 21, pp. 79-105. 1973.

Kraft, Gerald and Domencich, Thomas. "Free Transit." Edel, Matthew and Jerome Roghenberg, Readings in Urban Economics. New York: The MacMillan Company. 1972.

Lee, Y. and V. H. Surti. "Effect of Fare Reduction on Transit Patronage." Denver, Colorado: Center for Urban Transportation Studies, University of Colorado. Undated.

Levine, Harvey. "Using Efficiency Incentives to Allocate Transit-Operating Deficits." Traffic Q, 32:1, pp. 87-104. January 1978.

Lovelock, Christopher and John Twichell. "No Fare and Low-Fare Transit: An Evaluation of Their Feasibility and Potential Impact in the San Francisco Bay Area." Berkeley, California: Metropolitan Transportation Commission. 1973.

Mercer County Improvement Authority. Annual Report to the Department of Public Utilities for the Year 1976. March 28, 1977.

Nelson, Kenneth E. and Willian C. Nevel. "Cost-Effectiveness Analyses of Public Transit Systems." Traffic Quarterly, 33:2, pp. 241-252. April 1979.

Netzger, Dick. "The Case Against Low Subway Fares." New York Affairs 1, No. 3, pp. 14-25. 1974.

New Jersey Department of Transportation. "Application for Federal Assistance for the Mercer County Free Fare Demonstration." April 1976.

Peat, Marwick, Mitchell, and Company. "Public Transportation Fare Policy." 1979.

Pratt, R. H. and H. W. Bevis. An Initial Chicago North Suburban Transit Improvement Program 1971-1975--Volume II: Technical Supplement. Washington, D.C.: U. S. Department of Transportation, Urban Mass Transportation Administration, Project No. Ill-T9-2. July 1971.

Relish, Robert and Vasant H. Surti. "A Feasibility Study of Free Bus Service for a Street Corridor of Denver." Denver, Colorado: University of Colorado Center for Urban Transportation Studies. 1972.

Rhode Island Statewide Planning Program. "Evaluation of a 'No-Fare' System of Public Transit." Technical Paper 37, Providence, Rhode Island: Rhode Island Statewide Planning Program. 1973.

RTD. "Frontier." Volume VIII, No. 2. February 1979.

RTD. Transit Development Plan. Denver. 1977.

Scheiner, James I. "The Patronage Effects of Free Fare Transit." Traffic Quarterly, 29, pp. 19-27. 1975.

Scheiner, James I. "Exploding the Myths of Prepaid Transit." Transit Journal, 2, No. 1, pp. 57-64. 1976.

Scheiner, James I. and Grover Starling. "The Political Economy of Free-Fare Transit." Urban Affairs Quarterly, 10, pp. 170-184. 1974.

Scheiner, James I. and Ron Thorstad. Denver Off-Peak Free-Fare Demonstration, Early Survey Findings. August 1978.

Schneider, Lewis M. "The Problem of Free Mass Transportation." Proceedings of the Transportation Research Forum, 9 (supplemental papers). Oxford, Indiana: Richard B. Cross Company, pp. 23-30. 1968.

Schneider, Lewis M. "The Fallacy of Free Transportation," Harvard Business Review, 47, pp. 83-87. 1969.

Speilberg, Frank. "Plan for a Demonstration of Off-Peak Free-Fare Bus Service in Mercer County, New Jersey." Working Paper 5066-8-1. Washington, D.C.: The Urban Institude. February 1977.

Studenmund, A. H.; David Connor; and Sherrill Swan. "An Interim Analysis of the Free Fare Transit Experiments prepared for the 1979 Annual Meeting of the Transportation Research Board." Cambridge, Massachusetts: Transportation Systems Center. September 1978.

U.S. Department of Transportation. Report to Congress Concerning the Demonstration of Fare-Free Mass Transportation. Washington D.C.: U. S. Department of Transportation Urban Mass Transportation Administration. 1975.

Wachs, Martin. "The Feasibility of Fare-Free Transit for Los Angeles." Los Angeles, California: University of California at Los Angeles, School of Architecture and Urban Planning. 1973.

Wall Street Journal. "Free Transit--A Way Out of Traffic Jams." Business Horizons 2. 1959.

Wegmann, Frederick J., J. Ojo, and M. Kennedy. "An Analysis of System Tradeoffs to Improve Access to Special Generators. Wisconsin University. August 1973.

White, Weld & Co., et al. "Bond Prospectus--Sales Tax Revenue Bonds, Series 1977." Denver, Colorado: Regional Transportation District. October 1977.

APPENDICES

Appendix A: Data Collection and Reliability
LIST OF FIGURES

Appendix A
DATA COLLECTION AND RELIABILITY

Under the terms of the demonstration grant agreement, the Denver RTD was responsible for all data collection needed for the evaluation. With technical assistance in the design of survey instruments and procedures from the evaluation contractor, RTD and its data collection contractor administered surveys of transit operations, transit users and the general population.

The number and complexity of the issues to be addressed in the evaluation of free-fare in Denver required that an extensive and integrated system of data collection activities be employed. The validity of the evaluation results was contingent upon the survey samples being designed to insure both randomness (or at least control of biases) and the isolation of free fare and route restructuring effects. Three rounds of data collection were undertaken in the evaluation: Round One during the Off-Peak Free Fare Demonstration prior to Route Restructuring, Round Two during the Demonstration after Route Restructuring, and Round Three after both the Demonstration and Route Restructuring. A chronology of data collection activities is shown along with the sample size of each data set in Figure A.1.1.

The following sub-sections provide brief descriptions of the nature and limits of statistical confidence for each of the principal data collection activities. The survey instruments used in each round of on-board surveys are included in this appendix. Because of their excessive length, only Round One telephone surveys are included in this document by way of example.

On-Board Surveys

Three successive self-administered on-board surveys were conducted. Each was designed in a similar manner. The sample for each survey was essentially systemwide (with the exception of the Boulder and Longmont areas), and only weekday service was included. Ridership was sampled at different rates on each of the three intra-area service route types - Regular, Circulator, and Express. For example, the Round One sample was drawn from 120 randomly selected half-day driver assignments. The selected assignments were checked to insure that there was adequate representation with respect to the type of route, time of day, and geographical area. An unexpectedly high response rate was achieved in all three rounds of on-board surveys with about 8500 returns each.

Generally, the information obtained through the survey included trip characteristics and socio-economic data. The two surveys had many uses including estimating the impact of the fare-free program on various socio-economic groups such as low-mobility persons; other uses included analyses of new trip generation and changes in mode choice, impacts on group ridership, time-of-day shifts in travel, fare savings, and changes in trip lengths, purposes, and patterns.

Figure A.1.1
DATA COLLECTION CHRONOLOGY

Date	Data Collection Activity	Sample Size
Round One: During Demonstration/Pre-Route Restructuring		
8/21-25,27, 30/78	On-Board Survey 1	8,692[a]
8/28-29/78	CBD Cordon Corner Counts	360 Buses
9/26-29/78*	Random Household Telephone Survey 1	408
9/25-29/78	Transit User Follow-Up Telephone Survey 1	1011
Round Two: During Demonstration/Post-Route Restructuring		
9/25-29/78	Farebox Verification Survey 1	284 Bus Run Assignments
11/13-17/78	On-Board Survey 2	8,545[b]
11/20-21/78	CBD Cordon Corner Counts 2	471 Buses
12/11-15/78	Farebox Verification Survey 2	277 Bus Run Assignments
1/79	Random Household Telephone Survey 2	402
1/79	Transit User Follow-Up Telephone Survey 2 o Prior Rider 2 (from Follow-Up) o New Rider 1 (from On-Board 2)	 647 169
1/30,31/79	Special Corner Counts 1 (CBD, Route-Midpoint and Terminal Locations)	967 Buses
1/79	RTD Bus Drivers Survey	162
Round Three: Post-Demonstration/Post-Route Restructuring		
2/28, 3/1/79	Special Corner Counts 2 (CBD, Route-Midpoint and Terminal Locations)	967 Buses
3/12-16/79	On-Board Survey 3	8,682[c]
3/19-21/79	CBD Cordon Corner Counts 3	479 Buses

The weighted sample size was: a. 13,295; b. 14,692; c. 13,768. (Cases weighted to correct for non-response biases; weight equals number of forms distributed per assignment/number of usable forms returned.)

Figure A.1.1 (Cont'd)

Date	Data Collection Activity	Sample Size
3/19-23/79	Farebox Verification Survey 3	291 Bus Run Assignments
5/79	Random Household Telephone Survey 3	1001
	Transit User Follow-Up Telephone Survey 3	
5/79	o Prior Rider (from Prior Rider 2)	256
5/79	o New Rider (from New Rider 1)	96

Follow-Up Bus Rider Telephone Survey

Following each round of on-board surveys, telephone interview surveys were conducted in order to augment the general travel perceptual and response data obtained in the on-board surveys with more detailed information. The telephone surveys of bus riders were of a panel nature, i.e., the same persons were called during each survey to determine how their transit trip making had been changed or been affected by the service innovations. The initial Transit User Follow-Up Survey was a stratified random sample drawn from the On-Board Survey 1 respondents who provided telephone numbers. The initial panel comprised 1000 respondents; however, the attrition rate of this logitudinal sample was higher than expected. The sample size of willing respondants in Prior Rider 2 Follow-Up and Prior Rider 3 Follow-Up declined to around 650 and then to around 260 cases. A panel of approximately 200 transit users who began using RTD since Route Restructuring was drawn from the On-Board 2 sample. This data set and the post-free fare follow-up is primarily relevant to the evaluation of Route Restructuring impacts.

Random Household Telephone Surveys

At the same time as the follow-up bus rider telephone survey was conducted, general surveys of Denver area households were conducted. A sample of approximately 400 households was selected at random from the general population for the first two rounds of data collection. This sample size was determined to be sufficient for reliable detection of small changes in public attitudes. In Round 3, a random sample of around 1000 households was drawn in order to obtain more detailed travel behavior data and to allow greater sample stratification within acceptable confidence limits.

Field Surveys

Two separate field surveys were conducted: transit corner surveys and farebox (passenger) counter verification. Corner count surveys provided data relevant to several operational attributes; schedule adherence, passenger load factors, and time distribution of passenger boardings. Two sets of corner count data were collected, 1) CBD cordon counts and 2) special location counts. The CBD counts sampled the majority of the bus trips travelling outbound from the CBD during the hours of 2:30 p.m. to 6:30 p.m. on weekdays. The CBD counts provide observations of crowding and transit schedule deviation of the maximum load points for service routes. The special location corner count surveys were taken in late January 1979 just prior to the end of free fare and in late February 1979, one month after the reinstatement of off-peak fares. Selected CBD, route-midpoint, and route-terminal locations were observed during both a.m. and p.m. peak and mid-day off-peak periods: 8:00 a.m. to 11:00 a.m. and 2:00 p.m. to 6:00 p.m. These counts provide general systemwide load count data for the during and after demonstration periods controlling for seasonal variation.

Field surveys were also done to determine the accuracy rate of the farebox counters of Regular and Circulator routes. The farebox counters provide all of the basic ridership statistics for the during and post-free fare period. To derive the best estimates of ridership impacts, it was essential that both the level and direction of inaccuracy be measured, as well as any improvement in the farebox counting system over time. These field surveys were conducted by randomly selecting driver assignments and making 15-minute "unannounced" observations of the driver's use of counters. A systemwide sample of around 300 drivers (approximately half of all drivers) was surveyed in three rounds of data collection.

Bus Drivers Survey

A survey of RTD bus operators was conducted during a safety training session in January 1979. This survey was used to supplement other data regarding the operational impacts of the free fare demonstration, as well as to obtain data on transit operators' perceptions of the program. Approximately one-quarter of the RTD bus drivers were administered the survey instrument shown in Figure A.4.

Analysis of Confidence

The level of confidence that can be placed in the inferences drawn from the data used in this study is related to two reliability issues: 1) the quality of the data (degree of measurement error, absence of biases, etc.) and 2) the nature of the sample drawn from the universe in which we are interested (sample size, design, etc.). Only the first issue is relevant to the analysis of passenger count, and most of the supply-side data in this project. As discussed in Appendix B special efforts

have been made to eliminate known biases in this data. However, with respect to the survey data used in the evaluation, both the issue of measurement error, e.g., the precision and consistency of interview questions; and confidence in real differences among sampled groups and with their parent population are germane. Careful design of survey instruments with emphasis on precision and consistency of questions have hopefully minimized measurement error; however it remains a problem of largely indeterminate magnitude. In terms of statistical reliability, findings reported in the evaluation generally have been determined statistically significant at the .95 probability confidence level, unless otherwise noted.

Figure A.1.2 summarizes the generalized confidence intervals for the respective data sets. In general, the on-board surveys, because of large sample sizes, have the smallest estimated errors. However, other considerations have entered into the selection of data for analytical tasks. As a rule, the need for accuracy in the estimate of the population parameters was subordinate to other considerations, including data processing costs and the more common and greater need to measure changes, with links among socio-economic and travel characteristics.

Figure A.1.2
CONFIDENCE OF MEANS AND PROPORTIONS

	Approximate Sample Size	Reliability of 95% Confidence Means[1]	Proportions P=50%[2]	Proportions P=10%[2]
On-Board Surveys	8,600	±1% S	±1%	±.5%
Transit User Follow-Up Telephone Surveys:		±1% S	±1%	±.5%
o Follow-Up 1	1,000	±7% S	±4%	±2%
o Prior Rider 2	650	±8% S	±4%	±3%
o Prior Rider 3	260	±12% S	±4%	±4%
o New Rider 1	170	±16% S	±8%	±5%
o New Rider 2	100	±21% S	±11%	±6%
Random Household				
o Random 1 and 2	400	±10% S	±5%	±3%
o Random 3	1,000	±7% S	±4%	±2%
Corner Count Surveys	400	±10%	±5%	±3%
Farebox Verification Surveys	300	±11%	±5%	±3%

1. S = Standard deviation of sample for ratio type data.

2. P = 50%: for proportions of total equal to 50%.

   P = 10%: for proportions of total equal to 10%.

Figure A.2.1
ON-BOARD SURVEY 1 (3/76)

Dear Rider: The RTD is interested in providing you with the best possible bus service. Please help us by completing and returning this questionnaire before you get off the bus. All responses will be kept confidential. Thank you for your cooperation.

1. I am coming from: ☐ Home ☐ Work ☐ Shopping ☐ Recreational or Social ☐ School ☐ Other _____

2. After leaving that place, I walked . . . . . _____ Blocks to get to the bus stop ☐ I did not walk

3. I waited _____ minutes for the bus. 4. I have transferred to this bus. ☐ Yes ☐ No 5. I will transfer to another bus. ☐ Yes ☐ No

6. The place I am going to: ☐ Home ☐ Work ☐ Shopping ☐ Recreational or Social ☐ School ☐ Other _____

7. Instead of using the bus, I could have gone to this place by car. ☐ Yes, as a driver ☐ Yes, as a passenger ☐ No, car not available

IF YOU BOARDED THE BUS BETWEEN 6:00 A.M. AND 8:00 A.M. OR 4:00 P.M. TO 6:00 P.M., PLEASE SKIP TO QUESTION 12.

8. Before the "Free Fare Program" began in February, I was traveling to this place . . . . .

☐ Yes. If Yes, how? ☐ By bus ☐ By car, as a driver ☐ By car, as a passenger ☐ By walking ☐ Other _____

☐ No. If No, why? ☐ The bus was not free ☐ Other _____

9. I have changed the time of day that I travel to this place to take advantage of the free fare. ☐ Yes ☐ No

10. If the "Free Fare Program" is stopped, I would continue to travel to this place for the same reason.

☐ Yes. If Yes, How? ☐ By bus ☐ By car, as a driver ☐ By car, as a passenger ☐ By walking ☐ Other _____ ☐ No

11. I used RTD buses prior to the "Free Fare Program". ☐ Yes ☐ No

If Yes; because of the Free Fare Program, I now use the bus: ☐ More often ☐ Less often ☐ No change due to free fare

12. The total annual income of all persons in my household is:

☐ Under $5,000 ☐ $5,000 – $9,999 ☐ $10,000 – $14,999 ☐ $15,000 – 24,999 ☐ $25,000 or more

13. My age is: _____ 14. My race is: ☐ White ☐ Black ☐ Chicano ☐ Other

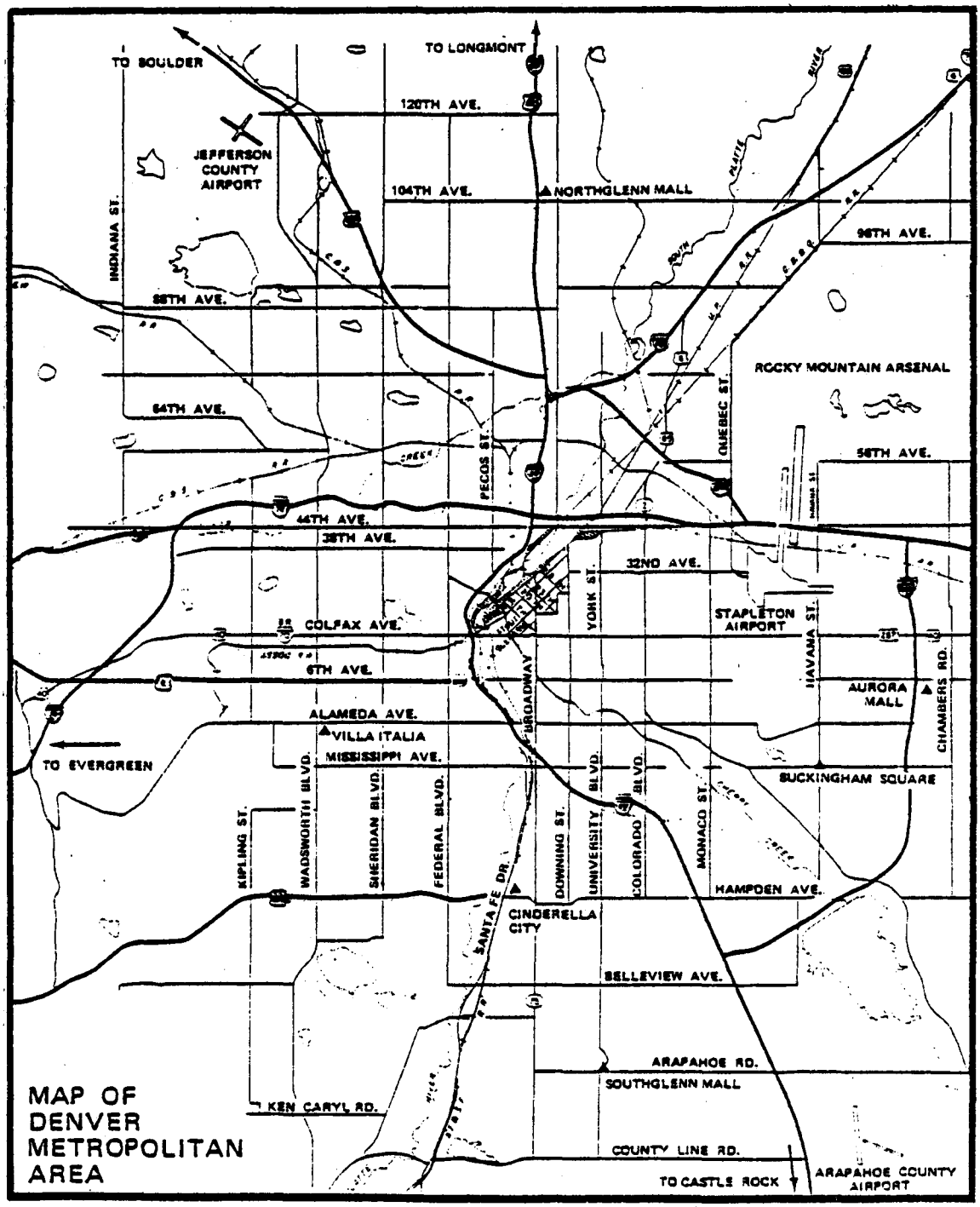
---

WE MAY NEED MORE INFORMATION ABOUT YOUR USE OF THE RTD. MAY WE CONTACT YOU BY PHONE?

Telephone No. _____ ☐ Day ☐ Evening Whom should we ask for (your name)? _____

SEE OTHER SIDE

Figure A.2.1 (cont.)
ON-BOARD SURVEY 1 (8/78)
(Reverse Side of Form)



Please mark with an X where this trip first began (bus stop).

Please mark with a circle where this trip finally ended (bus stop).

Figure A.2.2
ON-BOARD SURVEY 2 (1/79)

Dear Rider:

The RTD is interested in providing you with the best possible bus service. Please help us by completing and returning this questionnaire before you get off the bus. All responses will be kept confidential.

---

1. The place I am coming from:
   ☐ Home ☐ Work ☐ Shopping ☐ Recreational or Social ☐ School ☐ Other _____

2. After leaving that place, I walked . . .
   ____ blocks to get to the bus stop ☐ I did not walk

3. I waited ____ minutes for the bus.

4. I have transferred to this bus. ☐ Yes ☐ No

5. I will transfer to another bus. ☐ Yes ☐ No

6. The place I am going to:
   ☐ Home ☐ Work ☐ Shopping ☐ Recreational or Social ☐ School ☐ Other _____

7. Instead of using the bus, I could have traveled between these places by car.
   ☐ Yes, as a driver ☐ Yes, as a passenger ☐ No, car not available

8. Before September 10, when major changes were made in bus routes and schedules, I was traveling between these places. ☐ Yes ☐ No

   If Yes, how?
   ☐ By bus
   ☐ By car, as a driver
   ☐ By car, as a passenger
   ☐ By walking
   ☐ Other _____

   If No:
   I started riding the bus to travel between these places because of the bus service changes.
   ☐ Yes ☐ No

9. The September bus service changes have affected my bus travel between these places.
   ☐ Yes ☐ No (if no, skip to Question 11).

10. My bus travel between these places has changed because:

Time spent getting to the bus stop where I got on the bus:	☐ Less Now	☐ Same	☐ Takes Longer	
Time waiting for the bus:	☐ Less Now	☐ Same	☐ Takes Longer	
Transfers needed:	☐ Fewer Now	☐ Same	☐ More	☐ Never Used Transfers
Time spent on the bus:	☐ Less Now	☐ Same	☐ More	

11. I used RTD buses before the September bus service changes: ☐ Yes ☐ No
    If Yes: Because of the bus service changes, I now use the bus:
    ☐ More Often ☐ Less Often ☐ No Change

12. The total annual income of all persons in my household is:
    ☐ Under $5,000 ☐ $5,000-$9,999 ☐ $10,000-$14,999 ☐ $15,000-$24,999 ☐ $25,000 or More

13. My age is: _____ 14. My race is: ☐ White ☐ Black ☐ Chicano ☐ Other _____

15. My Sex: ☐ Male ☐ Female

We may need more information about your use of the RTD. May we contact you sometime later by phone?

Telephone No. _____ ☐ Day ☐ Evening

Whom should we ask for (your name)? _____

OTHER SIDE PLEASE

№ 06070

Figure A.2.2 (cont.)
ON-BOARD SURVEY 2 (1/79)
(Reverse Side of Form)

1. MARK THE PLACE YOU ARE COMING FROM WITH AN "X".

2. MARK THE PLACE WHERE YOU ARE GOING TO WITH AN "O".

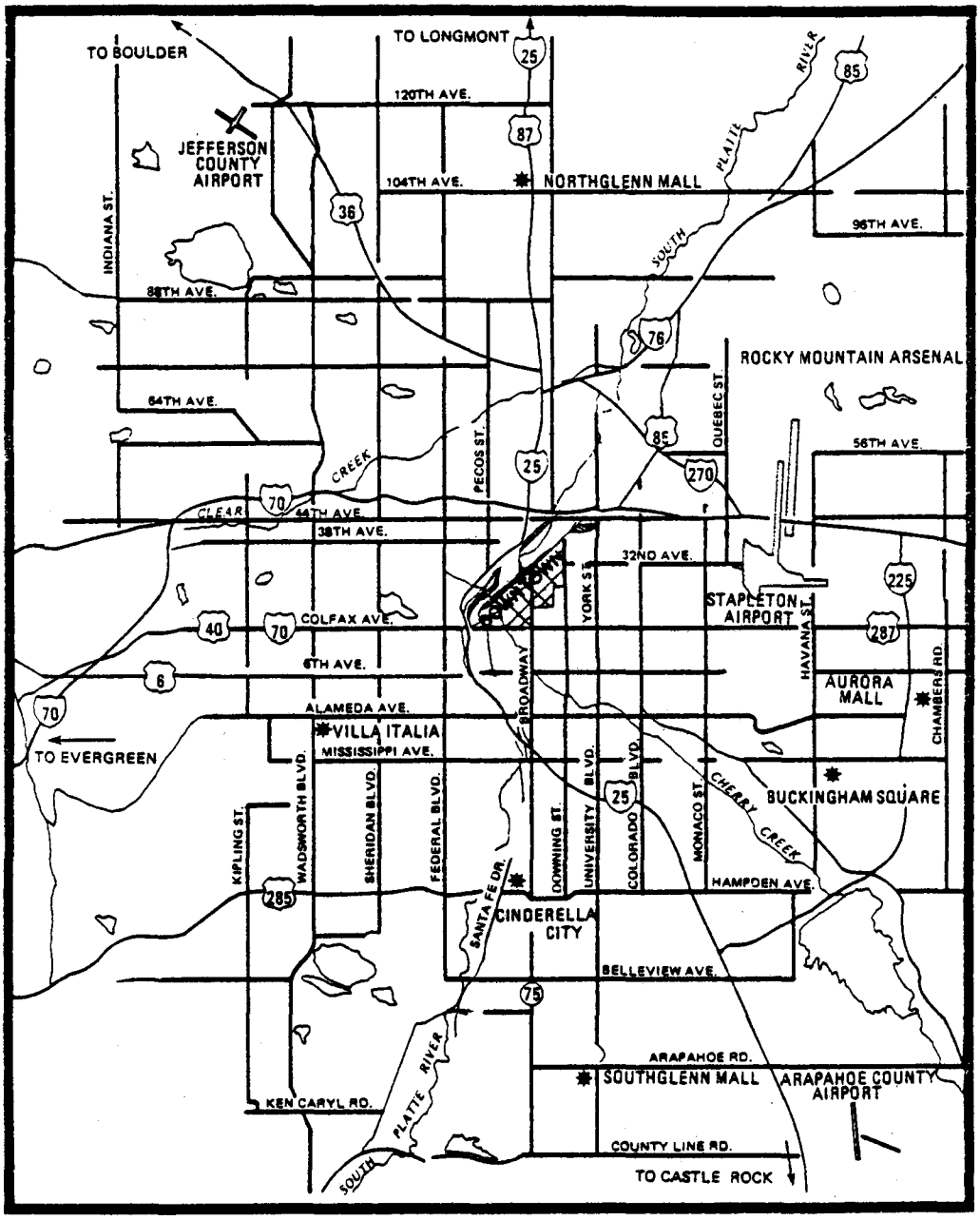


Figure A.2.3
ON-BOARD SURVEY 3 (3/79)

Dear Rider:

The RTD is interested in providing you with the best possible bus service. Please help us by completing and returning this questionnaire before you get off the bus. All responses will be kept confidential.

The place I am coming from:

☐ Home ☐ Work ☐ Shopping ☐ Recreational or Social ☐ School ☐ Other _____

2. After leaving that place I walked . . . _____ blocks to get to the bus stop ☐ I did not walk.

3. I waited ____ minutes for the bus.

4. I paid for this trip by: ☐ Cash: _____ ¢ (how much) ☐ Token ☐ Monthly Pass

5. I have transferred to this bus: ☐ Yes ☐ No

6. I will transfer to another bus. ☐ Yes ☐ No

7. The place I am going to:

☐ Home ☐ Work ☐ Shopping ☐ Recreational or Social ☐ School ☐ Other

8. Instead of using the bus, I could have traveled between these places by car:

☐ Yes, as a driver ☐ Yes, as a passenger ☐ No, car not available

9. On September 10, 1978, major changes were made to bus routes and schedules. Before that time, I was making this bus trip:

☐ Yes, I made this bus trip before service changes. ☐ No, I started making this bus trip because of service changes

☐ No, I started making this trip because of other reasons

10. Since September 10, more bus service changes have been made. The bus service changes made in September and more recently have affected the convenience of this bus trip for me. ☐ Yes ☐ No – skip to question 12

11. Convenience of this bus trip has changed in these ways:

Time spent getting to the bus stop where I got the bus:	☐ Less Now	☐ Same	☐ Takes Longer	
Time waiting for the bus:	☐ Less Now	☐ Same	☐ Takes Longer	
Transfers needed:	☐ Fewer Now	☐ Same	☐ More	☐ Never Used Transfers
Time spent on the bus:	☐ Less Now	☐ Same	☐ More	

12. I used RTD buses before the September bus changes: ☐ Yes ☐ No
If Yes: because of the bus service changes in September and later, I now use the bus:

☐ More Often ☐ Less Often ☐ No Change

13. RTD's Free Fare Program ended February 1, 1979. Because the Free Fare Program has ended, I have made the following change in the time of day when I make this bus trip:

☐ No Change ☐ Changed from free fare hours to rush hours (6–8 AM or 4–6 PM)

☐ Changed from rush hours to what were free fare hours ☐ This bus trip not made during Free Fare Program

14. Because the Free Fare Program has ended, I now use the bus:

☐ More often ☐ Less often ☐ No change ☐ Did not use bus before February 1

15. The total annual income of all persons in my household is:

☐ Under $5,000 ☐ $5,000–$9,999 ☐ $10,000–$14,999 ☐ $15,000–$24,999 ☐ $25,000 or More

16. My age: _____ My Race is: ☐ White ☐ Black ☐ Chicano ☐ Other _____

17. My Sex: ☐ Male ☐ Female

We may need more information about your use of the RTD. May we contact you sometime later by phone?

Telephone No. _____ ☐ Day ☐ Evening

Whom should we ask for (your Name)? _____

Figure A.2.3 (cont.)
ON-BOARD SURVEY 3 (3/79)
(Reverse Side of Form)

1. MARK THE PLACE YOU ARE COMING FROM WITH AN "X".

2. MARK THE PLACE WHERE YOU ARE GOING TO WITH AN "O".

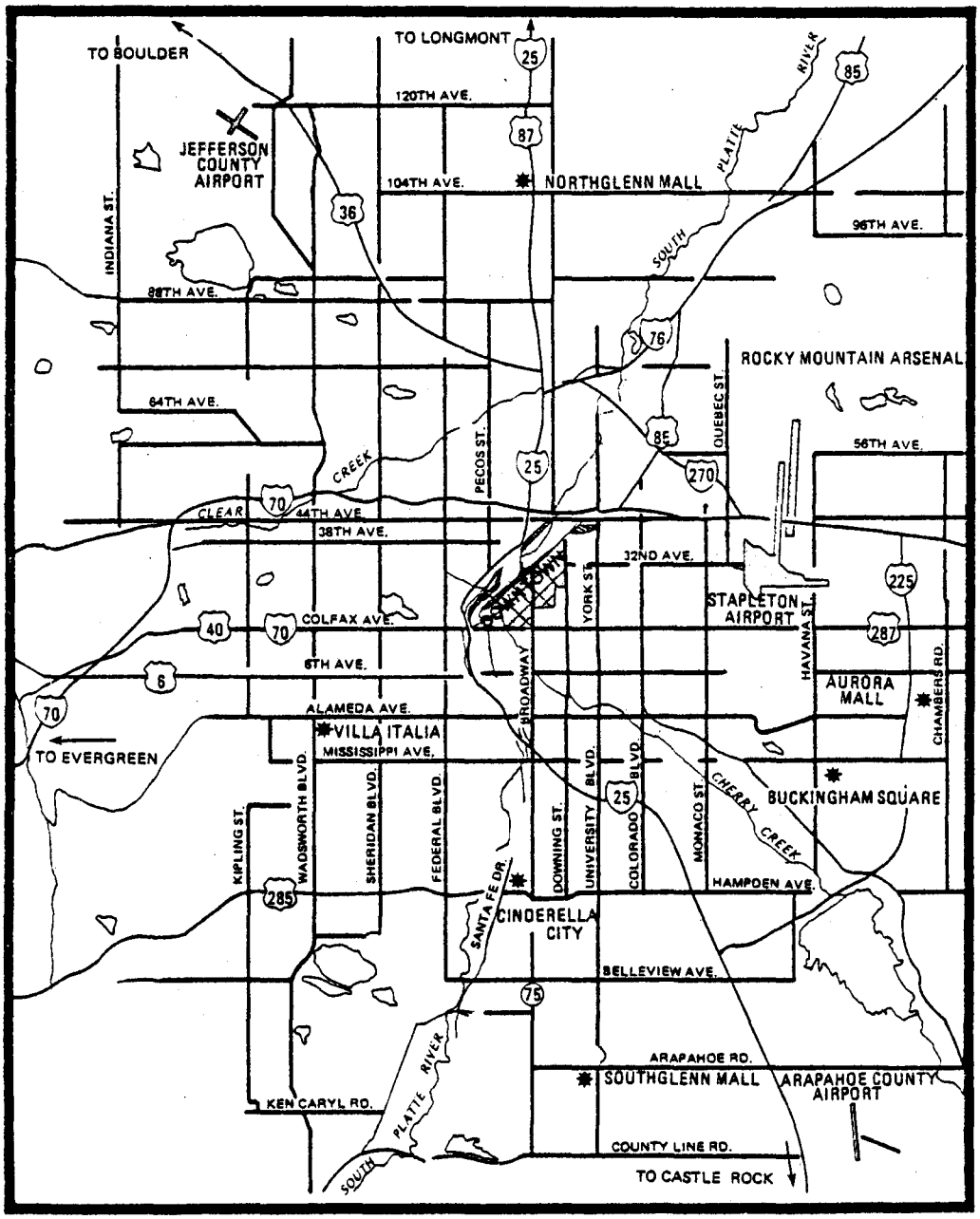


Figure A.2.4
TRANSIT USER FOLLOW-UP SURVEY 1 (10/78)*

NATIONAL ANALYSTS
A Division of Booz·Allen & Hamilton Inc.

CARD 04

Study 1-275
Fall, 1978

DENVER STUDY

(BUS RIDER SURVEY)

- Call Report Form -

(Circle Code)

RESPONDENT NUMBER: _____ (11-15) LIST: A B C D E F G H I

RESPONDENT NAME: _____

TELEPHONE #: _____

	1	2	3	16
TIME	AM PM	AM PM	AM PM	
DATE				17
RESULT*				

*RESULT OF CALL

1. Interview completed
2. Interview refused
4. Eligible respondent not home
5. No answer
7. Busy after 10 rings (call again in ½ hour)
8. Non-working number
9. Other

END CARD 04

*Similar transit user follow-up surveys were administered (1/79) and (5/79).

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

CARD 05

NATIONAL ANALYSTS
A Division of Booz-Allen & Hamilton Inc.

Study 1-275
Fall, 1978

DENVER STUDY

- BUS RIDER SURVEY -

(Circle Code)

RESPONDENT NUMBER: _____ List: A B C D E F G H I
11-15

RESPONDENT NAME: _____

TELEPHONE NUMBER: _____

INTERVIEWER NAME: _____

DATE OF INTERVIEW: _____

INTRODUCTION: Hello, may I speak with (RESPONDENT'S NAME). My name is _____ and I am calling as part of a federally funded bus demonstration project in Denver. As you may recall, a few weeks ago you filled out a questionnaire on one of the RTD buses and gave us your name and phone number in case we had more questions.

(1.) At that time, what was the address or street corner closest to the place you were coming from?

_____
STREET 16-40

_____
STREET 41-65

END CARD 05

(2.) What was the address or street corner closest to the place you were going to?

CARD 06

_____
STREET 11-35

_____
STREET 36-60

END CARD 06

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

CARD 07

3. Have you made that trip again since Sunday, September 10th?

11

	Yes	1
(SKIP TO Q.6)	No	2
	Don't Know	3

4. Since September 10th, how have you usually made that trip? (IF "CAR", PROBE: As a driver or as a passenger?) (CIRCLE ONLY A SINGLE CODE) 12

(SKIP TO Q.6)	Bus	1
	Car, as a driver	2
	Car, as a passenger	3
	Walking	4
	Other (PLEASE EXPLAIN):	0

5. Why don't you now use the bus for that trip?

13

Bus is too crowded	1
Don't know where to get the bus	2
Harder to get to work, shopping, etc.	3
Bus stops are further from origin or destination of trips	4
Reason not related to bus service	5
Other (EXPLAIN)	0

Now I have a few questions about your use of the bus service last week.

6. How many one-way bus trips did you make last week? By one-way bus trips I mean trips in just one direction and not round trips.

OF ONE-WAY TRIPS
14,15

IF "NONE", SKIP TO Q.9

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

7. How many of these one-way bus trips started outside the rush hours, that is, other than between 6 to 9 AM and 4 to 6 PM weekdays?

\# OF ONE-WAY TRIPS
16,17

IF "NONE", SKIP TO Q.9

8. How many of these one-way trips were for: (READ)

		RECORD NUMBER
18,19	Work or school?	
20,21	Shopping?	
22,23	Other activities?	
	TOTAL	

TOTAL SHOULD EQUAL ANSWER TO Q.7. IF IT DOES NOT ASK RESPONDENT TO CORRECT.

9. How satisfied or dissatisfied are you with the way the bus service in Denver is serving the public? Would you say you are: (READ)

24

	Very satisfied,	1
	Somewhat satisfied,	2
	Somewhat dissatisfied, or	3
	Very dissatisfied?	4
DO NOT READ	Don't know	5

10. Have you heard that the RTD has recently made major changes in many of the bus routes and schedules?

25

	Yes	1
(SKIP TO Q.21)	No	2

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

11. In your opinion, have the route changes: (READ)

		26
	Improved bus service	1
	Made it worse, or	2
(SKIP TO Q.13)	Had no effect?	3
(DO NOT READ)	No opinion	4

12. In what ways has service been made (better/worse)?

	27
Can get to work, shopping, etc. more easily	1
Bus stops are nearer to origin or destination of trips	2
Harder to get to work, shopping, etc	3
Bus stops are further from origin or destination of trips	4
Bus is too crowded	5
Bus is late, does not run on time	6
Trips take longer now	7
Other (EXPLAIN)	0

13. Because of the changes in bus service, have you changed the number of one-way bus trips that you make?

		28
	Yes	1
(SKIP TO Q.18)	No	2

14. Do you make more one-way bus trips, fewer one-way trips or have you stopped riding the bus?

		29
	More one-way trips	1
(SKIP TO Q.16)	Fewer one-way trips	2
(SKIP TO Q.21)	Stopped riding bus	3

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

15. How many more one-way bus trips do you make in a typical week for: (READ)

		NUMBER OF ADDITIONAL TRIPS
30,31	Work or school?	
32,33	Shopping?	
34,35	Other activities?	

SKIP TO Q.17

16. How many fewer one-way bus trips do you now make in a typical week for: (READ)

		NUMBER OF FEWER TRIPS
36,37	Work or school?	
38,39	Shopping?	
40,41	Other activities?	

17. What is it about the bus route changes which has caused you to ride (more/less) often?

42

Bus is too crowded	1
Don't know where to get the bus	2
Harder to get to work, shopping, etc.	3
Bus stops are further from origin or destination of trips	4
Other (EXPLAIN)	0

18. Because of the bus route changes, do your one-way trips require more transfers, about the same or fewer transfers?

43

More	1
About the same	2
Fewer transfers	3
Never used transfers	4

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

19. How about the locations of the bus stops you usually use. Because of the bus route changes, have most of these stops been moved to a better or to a worse place for you? 44

Moved to better place	1
Moved to worse place -	2
No change	3

20. Because of the route changes, do you or do you not: (READ)

	Yes	No
a. Go to any different places than you used to? 45	1	2
b. Ride the bus to downtown Denver more often? 46	1	2
c. Make trips more often? 47	1	2

21. Now I have a few more questions. Have you heard about the free fare bus program which allows everyone to ride the bus for free except between 6 to 8 AM and 4 to 6 PM weekdays? 48

	Yes	1
(SKIP TO Q.30)	No	2

22. How do you feel about the free fare program? Would you say you are: (READ) 49

	Strongly in favor,	1
	Somewhat in favor,	2
	Somewhat opposed, or	3
	Strongly opposed?	4
(DO NOT READ)	Don't know, no opinion	9

23. Why do you (favor/oppose) the program? 50

Encourages more people to ride buses	1
Lets me (personally) ride free	2
Lets people, in general, ride free	3
Relieves traffic congestion	4
Encourages undesirable/unruly people to ride bus	5
Cannot ride free all the time	6
Other (EXPLAIN)	0

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

24. Because of the free bus fares, do you or do you not: (READ)

		Yes	No
a. Go to any different places than you used to?	51	1	2
b. Ride the bus to downtown Denver more often?	52	1	2
c. Make trips more often?	53	1	2

25. When the free fare program ends do you think that: (READ)

		Should	Should Not
a. Elderly people should or should not still get to ride free?	54	1	2
b. Handicapped people should or should not get to ride free?	55	1	2
c. Young people, up to age 16, should or should not get to ride free?	56	1	2
d. People with low income, regardless of age, should or should not get to ride free?	57	1	2

26. Do you think that the free fare program should be continued as it is for everyone?

	58
Yes	1
No	2

27. Should it be expanded to include all hours of the day?

	59
Yes	1
No	2

28. (IF "YES" TO Q.26 AND Q.27, SKIP TO Q.29, OTHERWISE:) Should it be completely discontinued?

	60
Yes	1
No	2

END CARD 17

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

29. Continuation of free fares would have to be paid for somehow. CARD 88 Suppose the additional tax per household were between $10 and $20 per year. How do you feel about paying this amount? Would you say you are: (READ)

11

	Stongly in favor,	1
	Somewhat in favor,	2
	Somewhat opposed, or	3
	Strongly opposed?	4
(DON'T READ)	Don't know	9

30. Now I am going to read a list of different things about bus service. Please tell me how satisfied or dissatisfied you are with each of these. Would you say you are very satisfied, somewhat satisfied, somewhat dissatisfied or very dissatisfied with: (READ)

		Very satis-fied	Somewhat satis-fied	Somewhat dissat-isfied	Very dissat-isfied	Does not apply
a. The time spent getting to the bus stop?	12	1	2	3	4	
b. The time spent waiting for the bus?	13	1	2	3	4	
c. The bus arriving on time?	14	1	2	3	4	
d. The amount of delay while transferring to another bus?	15	1	2	3	4	9
e. Seat availability?	16	1	2	3	4	
f. The amount of time spent on the bus?	17	1	2	3	4	
g. A sense of security?	18	1	2	3	4	
h. Driver courtesy?	19	1	2	3	4	

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

31. (IF "YES" TO Q.10, ASK. OTHERWISE SKIP TO Q.32) Please tell me whether the bus route changes have made any of these things better or worse for you? Considering only the effect of the route changes. Would you say (READ STATEMENTS a-h) is much better, somewhat better, about the same, somewhat worse or much worse?

(READ)		Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse	Does not apply
a. The time spent getting to the bus stop?	20	1	2	3	4	5	
b. The time spent waiting for the bus?	21	1	2	3	4	5	
c. The bus arriving on time?	22	1	2	3	4	5	
d. The amount of delay while transferring to another bus?	23	1	2	3	4	5	9
e. Seat availability?	24	1	2	3	4	5	
f. The amount of time spent on the bus?	25	1	2	3	4	5	
g. A sense of security?	26	1	2	3	4	5	
h. Driver courtesy?	27	1	2	3	4	5	

32. (IF "YES" TO Q.21, ASK OTHERWISE, SKIP TO Q.33) Has the free fare program made any of these things better or worse for you? Consider only the effect of the free fare program? Would you say (READ STATEMENTS a-f) is much better, somewhat better, about the same, somewhat worse, or much worse?

		Much Better	Somewhat Better	About the Same	Somewhat Worse	Much Worse	Does not apply
a. The bus arriving on time?	28	1	2	3	4	5	
b. The amount of delay while transferring to another bus?	29	1	2	3	4	5	9
c. Seat availability?	30	1	2	3	4	5	
d. The amount of time spent on the bus?	31	1	2	3	4	5	
e. A sense of security?	32	1	2	3	4	5	
f. Driver courtesy?	33	1	2	3	4		

Figure A.2.4 (continued)
TRANSIT USER FOLLOW-UP SURVEY 1

33. When you have to go somewhere, is a car usually available to you as a driver or as a passenger or as both a driver and a passenger?

34

SKIP TO Q.35	Yes, as driver	1
	Yes, as passenger	2
	Yes, both	3
	No, not available	4

34. Do you have a driver's license?

35

Yes	1
No	2

END CARD 08

35. Please tell me the names of the two streets at the corner closest to your residence. What city is that?

CARD 09

STREET 11-35 _____

STREET 36-60 _____

CITY 61-75 _____

THANK YOU FOR HELPING US WITH THIS QUESTIONIARE.

END CARD 09

Figure A.2.5
RANDOM HOUSEHOLD SURVEY 1 (10/78)*

NATIONAL ANALYSTS
A Division of Booz-Allen & Hamilton Inc.

CARD 01

Study 1-275
Fall, 1978

SCREENING FORM

TELEPHONE NUMBER: _____

INTERVIEWER NAME: _____

DATE OF SCREENING: _____

SCREENING FORM NUMBER: _____

CONFIRM TELEPHONE NUMBER, THEN READ INTRODUCTION

INTRODUCTION: Hello, my name is _____ and I am calling as part of a federally funded bus demonstration project in Denver. Is this a private residence?

	Yes	1
(TERMINATE)	No	2

We are trying to find out how people feel about the RTD, the public bus service here in Denver. We are interested in your opinions and would appreciate your help in answering a few questions. The information you give to us will remain confidential.

1. So I may know whom to interview, please tell me how many persons live in your household who are 18 years old or older. Be sure to include yourself.

_____ # OF PERSONS

2. Please tell me the first name or initials of each of the males living here who are 18 years old or older, beginning with the oldest. What is the first name and age of the (next) oldest male? (RECORD NAME OR INITIALS AND AGE OF EACH MALE IN TABLE A. IF "NONE", CHECK BOX A)

TABLE A
MALES

BOX A
(IF NO MALES, CHECK HERE) ☐

	NAME OF MALES	AGE	SELECTION NUMBER
1.			
2.			
3.			
4.			
5.			

3. Please tell me the first name or initials of each of the females living here who are 18 years old or older, beginning with the oldest. What is the first name and age of the (next) oldest female? (RECORD NAME OR INITIALS AND AGE OF EACH FEMALE IN TABLE B. IF "NONE", CHECK BOX B.)

TABLE B
FEMALES

BOX B
(IF NO FEMALES, CHECK HERE) ☐

	NAME OF FEMALES	AGE	SELECTION NUMBER
1.			
2.			
3.			
4.			
5.			

BE SURE THE NUMBER OF MALES AND FEMALES IN TABLE A AND TABLE B EQUAL THE NUMBER OF PERSONS GIVEN IN Q.1. IF DIFFERENT, ASK RESPONDENT TO CORRECT ANSWERS.

IF THIS IS A BLUE FORM, SELECT AS THE RESPONDENT THE MALE IN TABLE A WITH THE LOWEST NUMBER (THE NUMBER CLOSEST TO "1") IN THE SELECTION NUMBER COLUMN. ASK TO SPEAK TO THAT PERSON. IF NO MALES IN THE HOUSEHOLD, INTERVIEW THE FEMALE WITH THE SMALLEST SELECTION NUMBER.

IF THIS IS A PINK FORM, SELECT AS THE RESPONDENT THE FEMALE IN TABLE B WITH THE LOWEST NUMBER (THE NUMBER CLOSEST TO "1") IN THE SELECTION NUMBER COLUMN. ASK TO SPEAK TO THAT PERSON. IF NO FEMALES IN THE HOUSEHOLD, INTERVIEW THE MALE WITH THE SMALLEST SELECTION NUMBER.

*Similar random household surveys were administered (1/79) and (5/79).

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

CALL REPORT FORM

	1	2	3	53
TIME				
DATE				
RESULT*				54

RESULT OF CALL

1. Interview completed
2. Interview refused
3. Screening refused
4. Eligible respondent not home
5. No answer
6. Business phone
7. Busy after 10 rings (call again in ½ hour)
8. Non-working number
9. Other

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

NATIONAL ANALYSTS
A Division of Booz-Allen & Hamilton Inc.

CARD 02

Study: 1-075
Fall, 1978

Denver Study

Male	1
Female	2

Respondent Name: _____

Screening Form Respondent Line #: _____

Respondent Telephone #: _____

Interviewer Name: _____

Date of Interview: _____

REPEAT INTRODUCTION IF INTERVIEW RESPONDENT IS DIFFERENT FROM SCREENING RESPONDENT.

INTRODUCTION: Hello, my name is _____ and I am calling as part of a federally funded bus demonstration project in Denver. Is this a private residence? 12

	Yes	1
(TERMINATE)	No	2

1. How many blocks or miles from your home is the nearest RTD bus stop? 15

NUMBER OF 13,14	Blocks	1
	Miles	2

2. About how many one-way bus trips were made by all the members of your household last week? By one-way trips, I mean trips in just one direction and not round trips.

NUMBER OF ONE-WAY TRIPS 16,17

IF "NONE", SKIP TO Q.5

3. About how many of these one-way bus trips did you, yourself, make?

NUMBER OF ONE-WAY TRIPS 18,19

IF "NONE", SKIP TO Q.5

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

4. About how many of your one-way bus trips last week were made using the bus service between 6 to 8 AM and 4 to 6 PM weekdays?

NUMBER OF ONE-WAY TRIPS [20,21]

5. How satisfied or dissatisfied are you with the way the bus service in Denver is serving the public? Would you say you are: (READ) [22]

	Very satisfied,	1
	Somewhat satisfied,	2
	Somewhat dissatisfied, or	3
	Very dissatisfied?	4
(DON'T READ)	Don't know	9

6. Have you heard about the free fare bus program which allows everyone to ride the bus for free except between 6 to 8 AM and 4 to 6 PM weekdays? [23]

	Yes	1
(SKIP TO Q.14)	No	2

7. How do you feel about the free fare program? Would you say you are: (READ) [24]

	Strongly in favor,	1
	Somewhat in favor,	2
	Somewhat opposed, or	3
	Strongly opposed?	4
(DON'T READ)	Don't know	9

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

8. Why do you say that you (favor/oppose) the program? (CODE ONLY FIRST RESPONSE.) 25

Encourages more people to ride buses	1
Lets me (personally) ride free	2
Lets people, in general, ride free	3
Relieves traffic congestion	4
Encourages undesirable/unruly people to ride bus	5
Cannot ride free all the time	6
Other (EXPLAIN)	0

9. When the free fare program ends, do you think that: (READ)

	Should	Should Not	
a. Elderly people should or should not still get to ride free?	1	2	26
b. Handicapped people should or should not get to ride free?	1	2	27
c. Young people, up to age 16, should or should not get to ride free?	1	2	28
d. People with low incomes, regardless of age, should or should not get to ride free	1	2	29

10. Do you think that the free fare program should be continued as it is for everyone? 30

Yes	1
No	2

11. Should it be expanded to include all hours of the day? 31

Yes	1
No	2

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

12. (IF "YES" TO Q.10 AND Q.11, SKIP TO Q.13, OTHERWISE)
Should it be completely discontinued? 32

	Yes	1
	No	2

13. Continuation of free fares would have to be paid for somehow. Suppose the additional tax per household were between $10 and $20 per year. How do you feel about paying this amount? Would you say you are: (READ) 33

	Strongly in favor,	1
	Somewhat in favor,	2
	Somewhat oppose, or	3
	Strongly oppose	4
(DON'T READ)	Don't know	9

14. Have you heard that the RTD has recently made major changes in many of the bus routes and schedules? 34

	Yes	1
(SKIP TO Q.17)	No	2

15. In your opinion, have the route changes: (READ) 35

	Improved bus service,	1
	Made it worse, or	2
(SKIP TO Q.17)	Had no effect?	3
(DON'T READ SKIP TO Q.17)	No opinion	9

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

16. In what ways has service been made (better/worse)? (CODE ONLY FIRST RESPONSE.)

36

Can get to work, shopping, etc. more easily	1
Bus stops are nearer to origin or destination of trips	2
Harder to get to work, shopping, etc.	3
Bus stops are further from origin or destination of trips	4
Other (EXPLAIN)	0

17. When you have to go somewhere, is a car usually available to you as a driver or as a passenger or as both a driver and a passenger?

37

Yes, as driver	1
Yes, as passenger	2
Yes, both	3
No, not available	4

18. Do you have a driver's license?

38

Yes	1
No	2

19. Please stop me when I read the range that includes <u>your</u> age: (READ)

39

18 to 24 years,	1
25 to 44 years,	2
45 to 64 years, or	3
65 or older?	4

Figure A.2.5 (continued)
RANDOM HOUSEHOLD SURVEY 1

20. Please stop me when I read the range that includes the <u>total</u> annual income of all members of your household: (READ)

40

Under $5,000,	1
$5,000 to $9,999,	2
$10,000 to $14,999,	3
$15,000 to $24,999,	4
$25,000 or more.	5

END CARD 02

21. Please tell me the names of the two streets at the corner closest to your residence. What city is that?

CARD 03

STREET 11-35

STREET 36-60

CITY 61-75

Thank you for helping us with this questionnaire.

END CARD 03

Figure A.3
RTD FREE FARE DEMONSTRATION
BUS CORNER COUNTS

OBSERVER ____________________ SUPERVISOR ____________________

DAY ____________________ DATE ____________________

LOCATION ____________________ DIRECTION ____________________

TIME START ____________ TIME END ____________ WEATHER ____________

Bus Route	Bus Number	Scheduled Time of Arrival	Actual Time of Arrival	Passenger Counts		
				Standees	Count One Only: Occupied Seats	Count One Only: Empty Seats

Figure A.4
DENVER RTD DRIVERS SURVEY

Time _____

Dear Bus Operator,

The impacts of the Free Fare Program and Route Restructuring are now being evaluated. It is important that your opinion of the effects of these programs be part of the evaluation. Please complete this form and then return it to the surveyor.

Thank you for your help.

1. How long have you been a bus operator for RTD?

_____ years _____ months

THE FREE FARE PROGRAM

2. What runs have you driven during the Free Fare Program?

- ☐ split
- ☐ matinee
- ☐ daylight
- ☐ night
- ☐ other _____ (please specify)

3. What route or routes have you driven during the Free Fare period?

_____

4. Has the Free Fare Program had a good or bad effect on on your job?

- ☐ good effect
- ☐ bad effect
- ☐ no effect

5. During your runs, has the Free Fare Program had a good or bad effect on any of the following factors?

		Good Effect	No Effect	Bad Effect
a.	Run times	☐	☐	☐
b.	Layovers	☐	☐	☐
c.	Schedule Adherence	☐	☐	☐
d.	Number of required stops	☐	☐	☐
e.	Crowding on the bus	☐	☐	☐
f.	Crime on the bus	☐	☐	☐
g.	Types of persons using service	☐	☐	☐
h.	Passenger arguments or fights with drivers	☐	☐	☐
i.	Passenger arguments or fights with others	☐	☐	☐
j.	Smoking, eating, or drinking on the bus	☐	☐	☐
k.	Offensive language, harassment, behavior	☐	☐	☐
l.	Vandalism on the bus	☐	☐	☐
m.	Frequency of joyriding by children	☐	☐	☐
n.	Frequency of joyriding by elderly	☐	☐	☐
o.	Number of people riding the bus for very short trips	☐	☐	☐
p.	Respect for the bus system	☐	☐	☐
q.	Any other effects?			

_____

_____

6. What is the most important good effect?

_____

_____

_____

7. What is the most important bad effect?

_____

_____

_____

8. Has the Free Fare Program caused your buses to run late more or less often than before?

- ☐ more often
- ☐ less often
- ☐ no change

9. How often are comments made to you by passengers about the Free Fare Program?

		Positive Comments	Negative Comments
a.	Daily	☐	☐
b.	At least once a week	☐	☐
c.	At least once a month, but not weekly	☐	☐
d.	Less often than once a month	☐	☐
e.	Never	☐	☐

10a. Have you made a special request to change the runs or routes you drive because of the Free Fare Program?

- ☐ no
- ☐ yes

If assignment change was made:

route and run shifted from:	route and run shifted to:

10b. What is about the Free Fare Program that caused you to make a request?

_____

_____

_____

OVER

Figure A.4 (continued)
DENVER RTD DRIVERS SURVEY

ROUTE RESTRUCTURING

11. What runs have you driven since route restructuring began in September?

☐ split
☐ matinee
☐ daylight
☐ night
☐ other _____
(please specify)

12. What route or routes have you driven since route restructuring?

_____

13. Has the route restructuring had a good or bad effect on your job?

☐ good effect
☐ bad effect
☐ no effect

14. During your runs, has route restructuring had a good or bad effect on any of the following factors?

	Good Effect	No Effect	Bad Effect
a. Run times	☐	☐	☐
b. Layovers	☐	☐	☐
c. Schedule Adherence	☐	☐	☐
d. Number of required stops	☐	☐	☐
e. Crowding on the bus	☐	☐	☐
f. Number of passengers asking route, schedule information	☐	☐	☐
g. Your ability to provide information to patrons	☐	☐	☐
h. Respect for the bus system	☐	☐	☐
i. Any other effects?			

_____

_____

15. What is the most important good effect?

_____

_____

16. What is the most important bad effect?

_____

_____

16. Listed below are a number of possible effects of route restructuring. Which effects are occurring more or less often because of route restructuring?

	More Often	About the Same	Less Often
a. Shortened layovers	☐	☐	☐
b. Longer layovers	☐	☐	☐
c. Buses running late	☐	☐	☐
d. Buses running early	☐	☐	☐
e. More frequent stops required	☐	☐	☐
f. Less frequent stops required	☐	☐	☐

17. How often are comments made to you by passengers about route restructuring?

	Positive Comments	Negative Comments
a. Daily	☐	☐
b. At least once a week but not daily	☐	☐
c. At least once a month but not weekly	☐	☐
d. Less often than once a month	☐	☐
e. Never	☐	☐

18a. Have you made a special request to change the runs or routes you drive because of route restructuring?

☐ no
☐ yes

If assignment change was made:

route and run shifted from:	route and run shifted to:

18b. What is it about route restructuring that caused you to make a request?

_____

_____

ANY COMMENTS OR SUGGESTIONS?

_____

_____

_____

_____

_____

_____

_____

Appendix B: Ridership Estimates
LIST OF TABLES

APPENDIX B

RIDERSHIP ESTIMATES

B.1 Estimation of Before, During and Post-Demonstrations Ridership

In order to estimate the ridership impacts of the free fare demonstration, it was necessary to take several measures to improve the quality of the ridership count data available from the transit operator. These steps included: 1) adjustments to reduce or eliminate counting biases, 2) normalization of monthly counts through the estimaion of weekly trips (average weekday, Saturday, and Sunday), 3) determination of peak and off-peak period ridership splits, and 4) conversion of adjusted unlinked trips (boarding) to linked trips (person-trips).

B.1.1 Adjustments to Reduce Counting Biases

Special efforts were made to account for suspected counting and transcription errors in RTD's passenger data (unlinked trips). In order to develop an estimate of the impact of off-peak fare elimination it was necessary to determine the magnitude of error in passenger count estimates prior to and during the free fare demonstration, particularly since overcounting was thought to be a problem in the pre-free fare period and undercounting was considered a potential source of error for during and after the demonstration period. The adjustment coefficients derived from the following passenger count reliability analyses are documented in Table B.3.

B.1.1.1 Pre-Free Fare

Prior to March 1978 (NOG) and January 1978 (MOG) RTD used the average fare method of estimating passenger boardings on its local, circulator and intercity routes. Analysis of the distribution of bus hours of service during August 1977 indicates that the average fare survey used by RTD under-sampled peak period riders by a factor of .95. Due to higher fares during peak hours this resulted in approximately a 2 percent under-estimation of the average fare for unlinked trips, and consequently a 2 percent over estimation of ridership based on the August 1977 average fare survey. It is assumed that ridership counts based on the average fare method of calculation during 1976 and 1977 reflect this same direction and magnitude of error.

Table B.1
REVISED AVERAGE FARE CALCULATION, AUGUST 1977 (WEEKDAY)

	No. of Passengers			Revenue	
	Original Survey	Adjusted Total	Weekday Fare ($)	Original Survey	Adjusted Total
Adult Peak	2,620	3,010	.35	$ 917.00	$1,053.50
Adult Off-Peak	3,630	3,445	.25	907.50	861.25
Adult Passes	521	NC	.2425	126.34	NC
Senior Citizens Peak	210	241	.25	52.50	60.25
Senior Citizens Off-Peak	450	427	.15	67.50	64.05
E&H Peak	55	63	.25	13.75	15.75
E&H Off-Peak	131	124	.15	19.65	18.60
E&H Passes	378	NC	.1531	57.87	NC
Student Regular	708	NC	.20	141.60	NC
Student Passes	296	NC	.1724	51.03	NC
Transfers	1,803	NC	.05	90.15	NC
Corrections (Free)					
Under 6	403	NC	0	0	NC
Free Transfers	141	NC	0	0	NC
Elderly	231	NC	0	0	NC
TOTAL	11,577	11,791	-	$2,444.89	$2,540.39

Average Fare:
Original Survey = $.2112
Adjusted Survey = $.2155

NC: No Adjustment Made

Source: RTD; Average Fare Survey, August 1977.

B.1.1.2 During and Post Free Fare

Prior to the Farebox Verification Surveys, it was suspected that the implementation of the registering farebox counting system, in which passenger boardings are counted manually by drivers, would result in a fairly substantial level of miscounting. Furthermore, it was expected that problems were greatest during the initial months of the farebox system and would be aggrevated during months in which major changes occurred in either counting and/or transcription procedures, such as in December 1978; or in bus service operations, such as, the beginning of free fare in February 1976 or the implementation of the route and schedule changes in March (NOG) and September (MOG) 1978. In general, improvement in accuracy rate over time was expected as machinery malfunctions were corrected and drivers learned the new procedures.

Three data points were obtained to provide an indication of the extent of miscounting and to detect any trend in improvement that might be measured. Farebox Verification Surveys were conducted during each round of data collection in the evaluation. These produced the following net measures of under-counting during the periods surveyed.

Table B.2
ACCURACY RATE OF REGISTERING FAREBOX SYSTEM

Week Surveyed	Boardings Observed	Farebox Recordings	Net Accuracy Rate
September 25-29, 1978	3291	2988	91
December 11-15, 1978	4353	3746	86
March 19-23, 1979	3184	3065	96

Source: Farebox Verification Survey; see Appendix D, Table D.1

Analyses of the frequency distribution of these data by time of day, loading conditions on buses, and by drivers performance shows considerable variation among the three surveys but with no clear causal patterns. In general, the three surveys do not provide an indication of improvement in accuracy rates over time. It appears that the September and December data reflect the impact of Route Restructuring and farebox system changes respectively. It appears that since the implementation of the registering farebox systems, it is reasonable to assume that RTD typically reports a 4 percent underrepresentation of actual passenger boardings (unlinked trips) in its Monthly Performance System. However, during times of special circumstances affecting driver

Table B.3
ADJUSTMENT FACTORS TO ACCOUNT FOR ESTIMATED COUNTING BIASES IN RTD MONTHLY PERFORMANCE REPORT PASSENGER COUNT DATA

TIME PERIOD	TYPE OF SERVICE						REASON/EVENT
	Local	Express	Circulator			Inter-City	
			Denver	Boulder	Longmont		
January 1977 through October 1977	.980	1.040[a]	.980	.980	.980	.980	Average fare method of passenger count over-estimated ridership
November				1.040	1.040		Begin registering farebox system in Boulder and Longmont
December							
January 1978	1.040	1.040	1.040			1.040	Begin registering farebox system in Denver
February	1.065	1.065	1.065	1.065	1.065	1.065	Begin free fare
March	1.045	1.045	1.045	1.065	1.065	1.045	Route restructuring: Boulder, Longmont, and one-quarter Denver
April	1.040	1.040	1.040	1.040	1.040	1.040	Stable rate of undercounting
May							
June							
July							
August							
September	1.065	1.065	1.065				Route restructuring: Denver (data point)
October	1.040	1.040	1.040				Stable rate of undercounting
November							
December	1.065	1.065	1.065	1.065	1.065	1.065	Change in farebox counting system (data point)
January 1979 through June 1979	1.040	1.040	1.040	1.040	1.040	1.040	Stable rate of undercounting--March (data point)

[a]Average fare method not used for express passenger counts. Four percent undercounting estimated.

attitudes or responsibilities, undercounding may be significantly higher, perhaps as much as 10 percent of actual. The estimate used for the adjustment of monthly RTD data in this evaluation, however was an average 6 percent rate of undercounting during these special months. It should be noted that the 4 and 6 percent adjustment factors may in fact understate the extent of undercounting which occurred during some months of the demonstration. However, without stronger indication of the magnitude of this error, a conservative approach to manipulation of the data base seems to be appropriate in order not to mask potentially significant, but small, free fare ridership effects.[1]

B.1.2 Estimation of Weekly Ridership

Because of variation from month-to-month in the total number and composition of days (weekdays, weekend days, holidays) represented in monthly passenger current data, it was necessary to estimate average weekly ridership per month to provide for normalized comparisions. Average weekday, Saturday, and Sunday ridership counts were estimated for the period from January, 1978 to June 1979 using weekday equivalents derived from RTD[2] estimates of weekday and weekend passenger count ratios by service type.[2] For 1976 and 1977, fare revenues and average fare data by day of week were used to calculate average weekday, Saturday and Sunday equivalents. The results of this work were a complete set of adjusted average daily ridership estimates (unlinked trips) by service type, for each month from 1976 to present.

B.1.3 Determination of Peak/Off-Peak Weekday Ridership Distribution

The estimation of ridership levels during the peak and off-peak hours of weekday operations is critical to the evaluation of the demonstration. Estimates of the peak/off-peak passenger split have been derived for the before, during, and post-demonstration typical weekday.

B.1.3.1 Pre-Demonstration and Base

Analysis of RTD's 1977 headway sheets indicated that 29.3 percent of the all day (weekday) hours of local service were provided during the peak hours from 7:00 to 9:00 a.m. and from 4:00 to 6:00 p.m. From average fare survey data passenger boardings per hour were determined for this time frame - 15.9 peak and 9.0 off-peak. Adjusting for the fact that virtually all express ridership occurs during the peak period, the best pre-demonstration period estimate of the total RTD scheduled service peak to off-peak split is 46 percent peak and 54 percent off-peak.

---

[1] If higher adjustment factors were used, the magnitude of estimated free fare impacts on RTD ridership would be proportionately larger. A larger differential between "normal" and "special" months would tend to amplify month-to-month seasonal variation.

[2] RTD weekday and weekend estimates could not be used directly in the analysis because they are only available from January 1978 on.

This serves as the basis for the estimation of the projected base without free fare peak to off-peak split for during and after the demonstration periods. Adjusting for the redefinition of the morning peak in May 1978 (6:00 to 8:00 a.m.) and for the effect of higher peak fares relative to off-peak fares (January, 1978 fare structure change), it is projected that off-peak ridership would have increased to 58 percent of total unlinked trips on a typical weekday in 1978 or 1979.

B.1.3.2 During and Post-Demonstration

A similar method was used to derive an estimate for the demonstration and post-demonstration period. Analysis of the hours of bus operation showed a slight increase in the percent of total service provided during the off-peak for both the during-demonstration period (71.3%) and for the post-demonstration period (72.1%). When applied to passenger boarding rates taken from the Farebox Verification surveys of local routes, it is estimated that the peak to off-peak ridership split for total scheduled service (unlinked trips) was 32 percent to 68 percent during the demonstration. Applying a similar method, a 42 percent to 58 percent split is estimated for the period after the reinstatement of off-peak fares.

A summary of the estimated weekday distribution of passenger boardings by time of day is given below:

Table B.4
SUMMARY OF PEAK/OFF-PEAK RIDERSHIP SPLIT (UNLINKED TRIPS)

	Observed		Base	
	Peak	Off-Peak	Peak	Off-Peak
Before: (August 1977)	46%	54%	45%	55%
During: (August, 1978)	32%	68%	42%	58%
After: (March, 1979)	43%	57%	42%	58%

Calculation of Linked Trips

Linked (person) trips were estimated using rates of transferring information obtained in On-Board Survey (8/78). The differential rates of peak and off-peak transferring have been incorporated in the calculations converting unlinked to linked ridership estimates.

Table B.5
RATE OF TRANSFERRING BY TIME OF DAY

Number of Links (Boardings)	Peak	Off-Peak	Weekday Total
1 No Transfer	82.2%	71.5%	75.2
2 Transfer Once	12.9	20.9	18.1
3 Transfer Twice	4.6	7.2	6.3
4+Transfer Three or More	.3	0.4	.4
Person Trips	100.0%	100.0%	100.0%
Linked Trips as Percent of Unlinked Trips	(82.1%)	(73.2%)	(76.8%)

Source: On-Board Survey (8/78)

B.2 Projection of Base Ridership

The general method used in the projection of base ridership is outlined in the text of Section 3.1.2. Table B.6 supplements this discussion with a summary of the important factors which affect transit ridership and were accounted for prior to the estimation of free-fare effects. The table documents specific values assumed or estimated from available data. Detailed ridership estimates of estimated actual, base and free fare effect are provided for reference in the remaining tables in this appendix.

Table B.6
SUMMARY OF FACTORS ACCOUNTED FOR IN PROJECTION OF BASE 1978 AND 1979 RIDERSHIP

Factors	Weekday Total	Weekday Peak	Weekday Off-Peak	Saturday	Sunday
Secular Growth					
1977-78[a] (Feb-Aug)	2.3%	-	-	3.0%	3.0%
1978-79[b] (Feb-June)	2.3%	-	-	3.0%	3.0%
Service Improvements					
Mileage Increase					
1977-78[a]	14.0%	-	-	85.0%	70.0%
1978-79[b]	7.0%	-	-	0	-15.0%
Estimated Service Elasticity	.6	-	-	.3	.3
New Fare Schedule (January, 1978)					
Average Fare Increase	43.0%	5%	25%	5.0%	5.05
Estimated Price Elasticity	-	-.3	-.4	-.4	-.4
Route Restructuring Ridership Impact	-4.0%	-	-	-4.0%	-4.0%

Table B.7
SUMMARY OF ESTIMATED FREE FARE RIDERSHIP IMPACTS

Evaluation Period		Projected Base	Actual	Estimated Free Fare Effect	
				Number	% Increase (% retained)
Weekday	1977[a]	(89,800)	89,800	-	-
	1978[a]	92,200	118,500	26,300	+29%
	1979[b]	96,100	101,100	5,000	(19%)
o Off-Peak	1977	(46,800)	46,800	-	
	1978	51,800	77,500	25,800	+50%
	1979	54,000	54,800	800	(3%)
o Peak	1977	(43,000)	43,000	-	
	1978	40,400	40,900	500	1%
	1979	42,200	46,400	4,200	(-)
Saturday	1977	(27,700)	27,700	-	
	1978	34,700	52,000	17,200	+50%
	1979	34,200	40,900	6,700	(39%)
Sunday	1977	(11,500)	11,500	-	
	1978	14,000	27,000	13,000	93%
	1979	13,100	19,000	5,900	(45%)
Week TOTAL	1977	(488,000)	488,000	-	
	1978	510,000	671,000	162,000	+32%
	1979	528,000	567,000	37,900	(23%)
o Off-Peak and Week-Ends	1977	(273,000)	273,000	-	
	1978	308,000	467,000	159,000	52%
	1979	317,000	334,000	17,000	(11%)
o Peak Week-days	1977	(215,000)	215,000	-	
	1978	202,000	205,000	3,000	1.5%
	1979	211,000	232,000	21,000	(-)

[a]Mean Average: February to August Pre-Route Restructuring.
[b]Mean Average: February to June only.

Table B.8
ESTIMATED NET EFFECT OF OFF-PEAK FREE FARE ON TRAVEL BEHAVIOR
PEAK AND OFF-PEAK AVERAGE WEEKDAY

Before Demonstration (Base Ridership)		During Demonstration (Estimated Ridership)		
Source Mode	Total	Changed To	Number From Source	Total
Peak Bus	41,200	Peak Bus	31,200	40,900
		Off-Peak Bus	10,000	
		Other Mode	-	
		Trip Not Made	-	
			41,200	
Off-Peak Bus	51,500	Peak Bus	3,900*	77,500
		Off-Peak Bus	45,500	
		Other Mode	1,200	
		Trip Not Made	1,000	
			51,500	
Other Mode (Increment)	21,900	Peak Bus	5,400*	-1,200
		Off-Peak Bus	16,500	
			21,900	
Trip Not Made (Increment)	6,000	Peak Bus	500*	1,000
		Off-Peak Bus	5,500	
			6,000	

*On-Board Survey 5/79).

Sources: On-Board Survey (8/78); DCCO Ridership Estimate.

Table B.9
LINKED AND UNLINKED ADJUSTED[1] RIDERSHIP ESTIMATES:
TOTAL MONTHLY SCHEDULED SERVICE--MOG AND NOG
(EXCLUDING SPECIAL, CHARTER, ELDERLY & HANDICAP)

Year and Month		RTD Unlinked	Adjusted Unlinked	Adjusted Linked
	June	2958630.	3076975.	2357807.
	May	2968420.	3087157.	2367714.
	April	3087453.	3210951.	2462707.
	March	3173474.	3300413.	2529709.
	February	2849024.	2962985.	2272175.
1979	January *	3571455.	3714313.	2815932.
	December *	3431351.	3654389.	2768168.
	November *	3574465.	3717444.	2817021.
	October *	3681457.	3828715.	2901508.
	September *	3470035.	3685024.	2789023.
	August *	3846690.	4000558.	3030530.
	July *	3615206.	3759814.	2844736.
	June *	3718956.	3867714.	2930298.
	May *	3680586.	3827809.	2899362.
	April *	3575236.	3718245.	2813938.
	March *	3874152.	4055101.	3075973.
	February *	3236130.	3446478.	2612933.
1978	January	2878979.	2994138.	2298752.
	December	2822740.	2776292.	2131549.
	November	2785606.	2740830.	2108128.
	October	2935483.	2887428.	2219351.
	September	2923032.	2874280.	2210383.
	August	2982799.	2933772.	2256989.
	July	2515574.	2474753.	1901712.
	June	2730416.	2685940.	2066416.
	May	2833255.	2787179.	2143662.
	April	2748988.	2704767.	2079632.
	March	3009464.	2961288.	2278701.
	February	2569403.	2527310.	1944342.
1977	January	2750670.	2705422.	2080264.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

[1]All ridership estimates shown in subsequent tables are adjusted passenger count data as discussed in the preceding documentation.

Table B.10.1
UNLINKED TRIPS BY TYPE OF SCHEDULED SERVICE:
MONTHLY TOTAL--MOG

Year and Month		Regular Denver	Express Denver	Circulator Denver	Total MOG
	June	2418152.	231395.	78076.	2727623.
	May	2393568.	223642.	83226.	2700436.
	April	2501094.	216238.	82148.	2799479.
	March	2586835.	225162.	70813.	2882809.
	February	2313295.	186368.	66381.	2566044.
1979	January *	2992082.	146478.	60219.	3196779.
	December *	2905052.	187262.	59428.	3151742.
	November *	2968598.	189899.	67588.	3226084.
	October *	3044729.	200658.	79300.	3324687.
	September **	2981124.	180715.	83770.	3245608.
	August *	3265116.	225692.	71141.	3561950.
	July *	3092807.	194272.	74303.	3361382.
	June *	3164977.	213188.	80740.	3458905.
	May *	3104693.	210774.	79324.	3394791.
	April *	3015238.	198552.	74931.	3288720.
	March *	3223146.	246016.	88281.	3557442.
	February *	2775730.	224206.	73179.	3073115.
1978	January	2461331.	197139.	69209.	2727679.
	December	2289379.	173445.	71381.	2534205.
	November	2217771.	189568.	69919.	2477259.
	October	2344368.	184675.	71392.	2600435.
	September	2364685.	166280.	67546.	2600511.
	August	2403198.	184240.	83820.	2671259.
	July	1994098.	164507.	79092.	2237697.
	June	2183751.	175632.	78421.	2437803.
	May	2274260.	183536.	83197.	2540993.
	April	2168647.	186477.	81689.	2436813.
	March	2383307.	208230.	88113.	2679650.
	February	2030181.	161119.	86441.	2277741.
1977	January	2196721.	169264.	86634.	2452619.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.10.2
UNLINKED TRIPS BY TYPE OF SCHEDULED SERVICE:
MONTHLY TOTAL--NOG

Year and Month		Circulator Boulder	Circulator Longmont	Inter-City	Total NOG
	June	214031.	21169.	114152.	349353.
	May	242635.	28738.	115547.	386721.
	April	269282.	31427.	110763.	411472.
	March	273753.	31271.	112580.	417604.
	February	267679.	32132.	97130.	396941.
1979	January *	342856.	53895.	118784.	515534.
	December *	331648.	51099.	119900.	502647.
	November *	316657.	50446.	124256.	491359.
	October *	332799.	48211.	123018.	504029.
	September **	291194.	39062.	109160.	439417.
	August *	280712.	40887.	117009.	438608.
	July *	264574.	35866.	97992.	398432.
	June *	272637.	38102.	98070.	408809.
	May *	286993.	41215.	104810.	433019.
	April *	278306.	37607.	113612.	429525.
	March *	310043.	42042.	145574.	497658.
	February *	226604.	35255.	111504.	373363.
1978	January	156807.	23831.	85822.	266459.
	December	139712.	24982.	77393.	242086.
	November	135495.	41948.	86129.	263572.
	October	169430.	31167.	86396.	286993.
	September	158400.	29624.	85744.	273769.
	August	146695.	34692.	81126.	262514.
	July	133541.	29902.	73614.	237056.
	June	139847.	30870.	77420.	248137.
	May	143888.	33020.	69278.	246186.
	April	155334.	39633.	72986.	267954.
	March	162993.	38068.	80578.	281638.
	February	147127.	34532.	67910.	249570.
1977	January	152266.	36676.	63861.	252803.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.11
UNLINKED TRIPS BY GENERAL TYPE OF SCHEDULED SERVICE
AVERAGE WEEKDAY--RTD
(CIRCULATOR INCLUDES BOULDER AND LONGMONT)

Year and Month		Regular	Express	Circulator	Inter-City
	June	99864.	11019.	13405.	4847.
	May	95544.	10166.	14504.	4712.
	April	104747.	10297.	16537.	4764.
	March	101928.	10235.	14989.	4602.
	February	102134.	9318.	16405.	4353.
1979	January *	120365.	6658.	18672.	4786.
	December *	123538.	9363.	18981.	4945.
	November *	123552.	9043.	18367.	5077.
	October *	119563.	9121.	18536.	4873.
	September **	123433.	9036.	17734.	4608.
	August *	123282.	9813.	15343.	4521.
	July *	126458.	9714.	16391.	4142.
	June *	124990.	9690.	16268.	3966.
	May *	122022.	9581.	16678.	4199.
	April *	125741.	9928.	16810.	4937.
	March *	126697.	10696.	17451.	5763.
	February *	124371.	11210.	14803.	4958.
1978	January	102102.	9388.	10546.	3691.
	December	94668.	8259.	10031.	3286.
	November	95608.	9027.	10918.	3776.
	October	99808.	8794.	11829.	3757.
	September	101930.	8013.	11268.	3758.
	August	95562.	8010.	10729.	3283.
	July	87809.	8225.	10998.	3312.
	June	90778.	7983.	10544.	3274.
	May	97666.	8740.	11475.	3023.
	April	92971.	8880.	12074.	3198.
	March	95137.	9053.	11744.	3270.
	February	92533.	8056.	12452.	3150.
1977	January	92863.	8060.	12084.	2740.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.12
LINKED TRIPS FOR TOTAL RTD SCHEDULED SERVICE:
WEEKDAYS, SATURDAYS, SUNDAYS AND WEEK TOTAL

Year and Month		Weekday	Saturday	Sunday	Week Total
	June	99468.	38509.	19106.	554957.
	May	96227.	40080.	18082.	539295.
	April	105023.	40390.	19134.	584638.
	March	101485.	43568.	19798.	570793.
	February	101838.	39700.	19152.	568044.
1979	January *	114438.	46676.	22319.	641184.
	December *	119264.	48542.	23364.	668225.
	November *	118664.	52414.	23082.	668818.
	October *	115664.	52682.	29236.	660236.
	September **	117731.	57302.	29579.	675536.
	August *	116322.	57143.	31636.	670391.
	July *	119171.	55026.	31031.	681912.
	June *	117825.	56062.	28477.	673662.
	May *	115958.	51596.	28380.	659766.
	April *	119711.	58047.	25895.	682499.
	March *	122139.	41487.	25209.	677389.
	February *	118135.	44442.	18117.	653233.
1978	January	97067.	39494.	17060.	541891.
	December	89746.	34723.	14653.	498107.
	November	92128.	28432.	11942.	501014.
	October	95879.	28992.	12186.	520574.
	September	96483.	29973.	12869.	525258.
	August	90782.	30298.	11954.	496161.
	July	85191.	26170.	11173.	463299.
	June	86917.	27163.	11397.	473145.
	May	93344.	28514.	11564.	506798.
	April	90424.	27044.	11376.	490541.
	March	92031.	28530.	11965.	500652.
1977	February	89705.	26479.	11080.	486086.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.1
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--WEEKDAYS

Year and Month		"Base" Person Trips	"Actual" Person Trips	Estimated Free Fare Impact
	June	91891.	99011.	7120.
	May	95884.	96111.	227.
	April	95012.	104901.	9889.
	March	98291.	101353.	3062.
	February	95229.	101742.	6513.
1979	January *	95351.	114292.	18941.
	December *	89519.	119068.	29549.
	November *	93112.	118562.	25450.
	October *	95559.	115520.	19961.
	September **	95567.	117611.	22044.
	August *	92155.	116234.	24079.
	July *	88165.	119026.	30861.
	June *	89851.	117735.	27884.
	May *	93602.	115880.	22278.
	April *	92781.	119583.	26802.
	March *	95860.	122032.	26172.
1978	February *	92985.	118055.	25070.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.1.1
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--WEEKDAY OFF-PEAK

Year	and Month	"Actual" Person Trips	"Base" Person Trips	Estimated Free Fare Impact
	June	53632.	51588.	2045.
	May	52062.	53829.	-1768.
	April	56823.	53340.	3483.
	March	54901.	55181.	-280.
	February	55112.	53462.	1650.
1979	January *	74808.	53530.	21278.
	December *	77934.	50256.	27678.
	November *	77603.	52273.	25330.
	October *	75611.	53647.	21965.
	September **	76980.	53651.	23329.
	August *	76079.	51736.	24343.
	July *	77906.	49496.	28411.
	June *	77062.	50442.	26619.
	May *	75848.	52548.	23299.
	April *	78271.	52087.	26184.
	March *	79874.	53816.	26059.
1978	February *	77271.	52202.	25069.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.1.2
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--WEEKDAY PEAK

Year and Month		"Actual" Person Trips	"Base" Person Trips	Estimated Free Fare Impact
June		45379.	40303.	5075.
May		44050.	42055.	1995.
April		48078.	41672.	6406.
March		46452.	43110.	3342.
February		46630.	41767.	4863.
1979 January	*	39484.	41821.	-2337.
December	*	41134.	39263.	1871.
November	*	40959.	40839.	120.
October	*	39908.	41912.	-2004.
September	**	40631.	41916.	-1285.
August	*	40155.	40419.	-264.
July	*	41119.	38669.	2450.
June	*	40673.	39409.	1265.
May	*	40033.	41054.	-1021.
April	*	41312.	40694.	618.
March	*	42158.	42044.	114.
1978 February	*	40784.	40783.	1.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.2
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--SATURDAYS

Year and Month		"Base" Person Trips	"Actual" Person Trips	Estimated Free Fare Impact
	June	33612.	38664.	5052.
	May	35284.	40026.	4742.
	April	33466.	40342.	6876.
	March	35304.	43521.	8217.
	February	32767.	39656.	6889.
1979	January *	35012.	46681.	11669.
	December *	31181.	48496.	17315.
	November *	34619.	52346.	17727.
	October *	34725.	52601.	17876.
	September **	35962.	57151.	21189.
	August *	36373.	56887.	20514.
	July *	33006.	54958.	21952.
	June *	34258.	56029.	21771.
	May *	35962.	51552.	15590.
	April *	34108.	58024.	23916.
	March *	35982.	41437.	5455.
1978	February *	33395.	44412.	11017.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.3
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
RTD TOTAL SCHEDULED SERVICE--SUNDAYS

Year and Month		"Base" Person Trips	"Actual" Person Trips	Estimated Free Fare Impact
	June	12995.	20771.	7776.
	May	13184.	18060.	4876.
	April	12970.	19114.	6144.
	March	13641.	19829.	6188.
	February	12633.	19135.	6502.
1979	January *	17191.	22379.	5188.
	December *	17420.	23393.	5973.
	November *	14104.	23045.	8941.
	October *	14403.	29193.	14790.
	September **	15238.	29512.	14274.
	August *	14119.	31900.	17781.
	July *	13664.	31004.	17340.
	June *	13939.	28470.	14531.
	May *	14142.	28371.	14229.
	April *	13912.	25909.	11997.
	March *	14632.	25238.	10606.
1978	February *	13550.	18125.	4575.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.4
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--WEEKLY TOTAL

Year and Month		"Actual" Person Trips	"Base" Person Trips	Estimated Free Fare Impact
	June	554490.	506062.	48428.
	May	538642.	527888.	10754.
	April	583963.	521496.	62467.
	March	570115.	540400.	29715.
	February	567501.	521545.	45956.
1979	January *	640520.	528958.	111562.
	December *	667228.	496196.	171032.
	November *	668201.	514283.	153918.
	October *	659391.	526923.	132468.
	September **	674717.	529035.	145682.
	August *	669956.	511267.	158689.
	July *	681092.	487495.	193597.
	June *	673175.	497452.	175723.
	May *	659325.	518114.	141211.
	April *	681848.	511925.	169923.
	March *	676837.	529914.	146923.
1978	February *	652811.	511870.	140941.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

B.13.4.1
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--WEEKLY TOTAL OFF-PEAK
(INCLUDES WEEKDAY OFF-PEAK, SATURDAYS AND SUNDAYS)

Year and Month		"Actual" Person Trips	"Base" Person Trips	Estimated Free Fare Impact
	June	327596.	304545.	23051.
	May	318394.	317614.	780.
	April	343571.	313135.	30437.
	March	337854.	324848.	13007.
	February	334349.	312708.	21641.
1979	January *	443100.	319853.	123247.
	December *	461559.	299881.	161678.
	November *	463406.	310088.	153317.
	October *	459851.	317362.	142489.
	September **	471564.	319457.	152107.
	August *	469182.	309171.	160011.
	July *	475495.	294149.	181346.
	June *	469807.	300409.	169398.
	May *	459161.	312845.	146316.
	April *	475288.	308456.	166832.
	March *	466047.	319693.	146354.
1978	February *	448892.	307954.	140938.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table B.13.4.2
ESTIMATED FREE FARE EFFECT BY MONTH--LINKED TRIPS
TOTAL RTD SCHEDULED SERVICE--WEEKLY TOTAL PEAK

Year and Month		"Actual" Person Trips	"Base" Person Trips	Estimated Free Fare Impact
	June	226894.	201517.	25377.
	May	220248.	210274.	9975.
	April	240391.	208361.	32030.
	March	232260.	215552.	16708.
	February	233152.	208837.	24315.
1979	January *	197420.	209105.	-11685.
	December *	205670.	196315.	9354.
	November *	204796.	204195.	601.
	October *	199540.	209561.	-10021.
	September **	203153.	209578.	-6426.
	August *	200774.	202096.	-1322.
	July *	205597.	193346.	12251.
	June *	203367.	197043.	6324.
	May *	200164.	205269.	-5106.
	April *	206559.	203469.	3090.
	March *	210790.	210221.	569.
1978	February *	203920.	203916.	4.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Appendix C: Monthly Revenue, Operating and Performance Indicator Data

LIST OF TABLES

Table C.1
ESTIMATED MONTHLY REVENUES AND OPERATING COSTS:
TOTAL RTD SCHEDULED SERVICE

Year and Month		Monthly Revene	Monthly Operating Cost	Weekday Revenue	Weekday Operating Cost
	June	940254.	3349301.	39431.	NA.
	May	908724.	3753448.	36728.	145708.
	April	894794.	3326414.	37951.	134346.
	March	984359.	3287705.	39249.	126548.
	February	942242.	3090605.	42004.	131852.
1979	January *	579398.	3295987.	26336.	127950.
	December *	424172.	3523084.	21209.	143098.
	November *	425706.	3015683.	20272.	121797.
	October *	484922.	3052688.	22042.	118505.
	September **	403359.	2806167.	20168.	115480.
	August *	465616.	2840613.	20244.	107436.
	July *	401776.	2873779.	20089.	116725.
	June *	408205.	2765358.	18555.	108701.
	May *	467359.	3002346.	21244.	116551.
	April *	404169.	2874952.	20208.	118311.
	March *	462764.	2667370.	20120.	100884.
	February *	344825.	2473137.	17241.	105509.
1978	January	767748.	2529239.	32219.	101129.
	December	635939.	3370349.	26607.	133215.
	November	671105.	2504092.	29197.	101135.
	October	680465.	2684194.	29249.	106095.
	September	676578.	2232376.	29399.	90161.
	August	702985.	2681986.	28160.	101437.
	July	589736.	2279614.	26269.	90103.
	June	649563.	2472948.	27211.	97207.
	May	675080.	2564205.	29259.	102282.
	April	654363.	2330612.	28318.	93299.
	March	721836.	2355991.	29040.	89107.
	February	613824.	2046261.	28201.	87298.
1977	January	660573.	NA.	28225.	NA.

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table C.2
ESTIMATED REVENUES AND OPERATING COSTS PER LINKED TRIP
TOTAL RTD SCHEDULED SERVICE

Year and Month	Average Fare per Unlinked Trip	Revenue per Person Trip	Operating Costs per Person Trip	Subsidy per Person Trip
June	.306	.399	1.421	1.022
May	.294	.384	1.585	1.201
April	.279	.363	1.351	.987
March	.298	.389	1.300	.911
February	.318	.415	1.360	.946
1979 January *	.156	.206	1.170	.965
December *	.116	.153	1.273	1.119
November *	.115	.151	1.071	.919
October *	.127	.167	1.052	.885
September **	.109	.145	1.006	.862
August *	.116	.154	.937	.784
July *	.107	.141	1.010	.869
June *	.106	.139	.944	.804
May *	.122	.161	1.036	.874
April *	.109	.144	1.022	.878
March *	.114	.150	.867	.717
February *	.100	.132	.946	.815
1978 January	.256	.334	1.100	.766
December	.229	.298	1.581	1.283
November	.245	.318	1.188	.869
October	.236	.307	1.209	.903
September	.235	.306	1.010	.704
August	.240	.311	1.188	.877
July	.238	.310	1.199	.889
June	.242	.314	1.197	.882
May	.242	.315	1.196	.881
April	.242	.315	1.121	.806
March	.244	.317	1.034	.717
February	.243	.316	1.052	.737
1977 January	.244	.318	NA	NA

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table C.3
ESTIMATED SERVICE HOURS, SERVICE MILES AND
AVERAGE SYSTEM SPEED:
TOTAL RTD SCHEDULED SERVICE

Year and Month		Service Hours	Service Miles	Average Speed
	June	NA.	NA.	NA.
	May	137782.	1924580.	13.97
	April	132471.	1860967.	14.05
	March	139018.	1949606.	14.02
	February	124183.	1741245.	14.02
1979	January *	134796.	1911344.	14.18
	December *	130936.	1813577.	13.85
	November *	129111.	1803139.	13.97
	October *	134327.	1877021.	13.97
	September **	124032.	1738864.	14.02
	August *	128513.	1820520.	14.17
	July *	120662.	1692461.	14.03
	June *	120662.	1819610.	15.08
	May *	136490.	1935229.	14.18
	April *	129088.	1829154.	14.17
	March *	139131.	1978701.	14.22
	February *	107319.	1525321.	14.21
1978	January	113736.	1598922.	14.06
	December	114854.	1612571.	14.04
	November	112183.	1575577.	14.04
	October	114624.	1608496.	14.03
	September	111472.	1569084.	14.08
	August	119629.	1697080.	14.19
	July	110308.	1563180.	14.17
	June	114069.	1621166.	14.21
	May	110428.	1541631.	13.96
	April	110796.	1549599.	13.98
	March	115652.	1609446.	13.92
	February	100939.	1336798.	13.24
1977	January	107949.	1416750.	13.12

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table C.4
ESTIMATED SERVICE PERFORMANCE INDICATORS--
PASSENGERS AND REVENUES PER HOUR AND MILE
TOTAL RTD SCHEDULED SERVICE

Year and Month	Unlinked Trips per Hour	Unlinked Trips per Mile	Revenue per Hour	Revenue per Mile
June	NA	NA	NA	NA
May	22.406	1.604	6.595	.472
April	24.239	1.725	6.755	.481
March	23.741	1.693	7.081	.505
February	23.860	1.702	7.588	.541
1979 January *	27.555	1.943	4.298	.303
December *	27.910	2.015	3.240	.234
November *	28.793	2.062	3.297	.236
October *	28.503	2.040	3.610	.258
September **	29.710	2.119	3.252	.232
August *	31.130	2.197	3.623	.256
July *	31.160	2.222	3.330	.237
June *	32.054	2.126	3.383	.224
May *	28.045	1.978	3.424	.242
April *	28.804	2.033	3.131	.221
March *	29.146	2.049	3.326	.234
February *	32.114	2.260	3.213	.226
1978 January	26.325	1.873	6.750	.480
December	24.172	1.722	5.537	.394
November	24.432	1.740	5.982	.426
October	25.190	1.795	5.936	.423
September	25.785	1.832	6.069	.431
August	24.524	1.729	5.876	.414
July	22.435	1.583	5.346	.377
June	23.547	1.657	5.694	.401
May	25.240	1.808	6.113	.438
April	24.412	1.746	5.906	.422
March	25.605	1.840	6.241	.448
February	25.038	1.891	6.081	.459
1977 January	25.062	1.910	6.119	.466

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Table C.5
ESTIMATED PERFORMANCE INDICATORS--
SUBSIDY PER HOUR AND MILE
TOTAL RTD SCHEDULED SERVICE

Year and Month		Operating Costs per Hour	Operating Costs per Mile	Subsidy per Hour	Subsidy per Mile
	June	NA	NA	NA	NA
	May *	27.242	1.950	20.647	1.478
	April	25.111	1.787	18.356	1.307
	March	23.649	1.686	16.569	1.181
	February	24.888	1.775	17.300	1.234
1979	January *	24.452	1.724	20.153	1.421
	December *	26.907	1.943	23.667	1.709
	November *	23.357	1.672	20.060	1.436
	October *	22.726	1.626	19.116	1.368
	September **	22.625	1.614	19.372	1.382
	August *	22.104	1.560	18.481	1.305
	July *	23.817	1.698	20.487	1.461
	June *	22.918	1.520	19.535	1.295
	May *	21.997	1.551	18.573	1.310
	April *	22.271	1.572	19.140	1.351
	March *	19.172	1.348	15.846	1.114
	February *	23.045	1.621	19.832	1.395
1978	January	22.238	1.582	15.488	1.102
	December	29.345	2.090	23.808	1.696
	November	22.321	1.589	16.339	1.163
	October	23.417	1.669	17.481	1.246
	September	20.026	1.423	13.957	.992
	August	22.419	1.580	16.543	1.166
	July	20.666	1.458	15.320	1.081
	June	21.679	1.525	15.985	1.125
	May	23.221	1.663	17.107	1.225
	April	21.035	1.504	15.129	1.082
	March	20.371	1.464	14.130	1.015
	February	20.272	1.531	14.191	1.072
1977	January	NA	NA	NA	NA

* Free Fare Off Peak Demonstration

** Route Restructuring Implemented in Denver

Appendix D: Results of Operational Monitoring Surveys
LIST OF TABLES

Table D.1
RESULTS OF FAREBOX VERIFICATION SURVEY

	September 1978	December 1978	March 1979
A. Passenger Boardings Observed	3,291	4,353	3,184
B. Farebox Recordings	2,988	3,746	3,065
C. Net Error	-303	-607	-119
D. Net Accuracy Rate (B/A)	90.8%	86.1%	96.3%
E. Mean per Driver Observed	92.5%	85.2%	94.9%
F. Undercounted Boardings	-363	-825	-287
G. Overcounted Boardings	60	218	168
H. Gross Error	423	1,043	455
I. Gross Accuracy Rate	87.1%	76.0%	85.7%

Table D.2
RESULTS OF SCHEDULE ADHERENCE ANALYSIS: BEFORE AND DURING

Deviation from Schedule (Minutes)	1977[a]		August 1978[b]					
			Weekday		Off-Peak		Peak	
	n	%	n	%	n	%	n	%
-6 or more early	87	3	3	1	-	-	3	2
-1 to -5	571	22	33	11	12	10	21	11
0 to 2	1,357	52	109	35	46	39	63	32
3 to 5	353	14	91	29	37	32	54	28
6 to 9	154	6	57	18	14	12	43	22
10 or more late	71	3	19	6	7	6	12	6
	2,593	100%	312	100%	116	110%	196	100%

[a]RTD Checker Counts, 1977: Routes 3, 6, 14, and 60..

[b]CBD Cordon Corner Counts: 2:30 PM to 6:30 PM.

Table D.3
RESULTS OF CBD CORDON CORNER COUNT SURVEY (8/78):
AVERAGE LOAD FACTORS--NINE ROUTES OBSERVED
2:00 PM TO 6:30 PM

Number of Passengers	Peak Buses Observed			Off-Peak Buses Observed		
	Number	Percent	Cumulative Percent	Number	Percent	Cumulative Percent
0-9	1	3%	3%	0	-%	-%
10-19	5	13	16	1	4	4
20-29	12	31	47	3	14	18
30-39	3	8	55	2	9	27
40-49	7	18	73	8	36	63
50-59	5	13	86	5	23	86
60-69	4	11	97	1	5	91
70+	1	3	100%	2	9	100%
	38	100%	-	22	100%	-
Average Bus Capacity	51.6 seats			51.5 seats		
Average Load	38.6 passengers			44.6 passengers		
Percent Capacity	71.4			86.7		

Table D.4
RESULTS OF CBD CORDON CORNER COUNT SURVEY (8/78) BUSES WITH STANDING PASSENGERS--
NINE ROUTES OBSERVED BETWEEN 2:00 PM AND 6:30 PM

Route		Peak Buses Observed				Off-Peak Buses Observed			
		Buses Observed	With Standing Passengers	Percent	Average Standing (on Buses with Standees)	Buses Observed	With Standing Passengers	Percent	Average Standing (on Buses with Standees)
3	South Broadway	13	1	8%	5	12	3	25%	9
4	East 1st-West 23rd	11	2	18	15	9	1	11	4
6	East 6th	23	6	26	6	17	2	12	5
8	East Evans-West 29th	15	5	33	11	11	2	18	11
13	East 13th West 38th	12	4	33	9	8	2	25	27
23	East 23rd West Alameda	8	0	0	0	8	1	0	9
32	32nd	26	4	15	6	20	8	40	9
60	South Federal	14	4	29	11	11	3	27	8
84	West 10th	5	0	0	0	4	0	0	0
Nine Routes Observed:		127	26	21%	9	100	22	22%	10

Table D.5
RESULTS OF SPECIAL CORNER COUNTS (1/79 AND 2/79)
BUSES WITH STANDING PASSENGERS

	Downtown Points (5 Locations: Morning)				Terminal Points (5 Locations: Afternoon)			
	Free Fare (Jan '79)		Post-Free Fare (Feb '79)		Free Fare (Jan '79)		Post-Free Fare (Feb '79)	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Total Routes Observed	14	14	14	14	17	17	17	17
With Standees	2	1	4	0	0	0	0	0
Total Buses Observed	97	255	97	255	103	85	103	85
With Standees	4	1	7	0	0	0	0	0
Percent With Standees	4%	%	7%	0%	-	-	-	-
Percent With 15+ Standees	-	-	5%	-	-	-	-	-
Total Standees Observed	22	6	135	0	0	0	0	0
Mean Per Bus (Buses With Standees Only)	5.5	-	19.3	-	-	-	-	-

Table D.5 (cont'd.)
RESULTS OF SPECIAL CORNER COUNTS (1/79 AND 2/79)
BUSES WITH STANDING PASSENGERS

	Midpoints (5 Locations: Morning)				Midpoints (5 Locations: Afternoon)			
	Free Fare (Jan '79)		Post-Free Fare (Feb '79)		Free Fare (Jan '79)		Post-Free Fare (Feb '79)	
	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak	Peak	Off-Peak
Total Routes Observed	11	11	11	11	11	11	11	11
With Standees	5	2	7	2	6	4	7	3
Total Buses Observed	55	153	55	153	112	89	112	89
With Standees	8	3	19	3	16	6	22	4
Percent With Standees	15%	2%	35%	2%	14%	7%	20%	5%
Percent With 15+ Standees	7%	1%	7%	-	6%	0%	5%	1%
Total Standees Observed	128	37	135	30	208	33	228	35
Mean Per Bus (Buses With Standees Only)	16.0	12.3	7.1	10.0	13.0	5.5	10.4	8.8

Table D.6
RESULTS OF BUS DRIVER SURVEY (1/79) FREE FARE EFFECTS

Effects on Drivers' Job

	Boulder		Alameda		Platte		Total	
	#	%	#	%	#	%	#	%
Good Effect	-	0 -	2	6.7	5	5.1	7	4.6
Bad Effect	24	92.3	24	80.0	71	73.2	119	77.8
No Effect	2	7.7	4	13.3	21	21.7	27	17.6
No Response	2				9	(8.5)	9	(5.6)
TOTAL	26	100.0	30	100.0	106	100.0	162	100.0

Most Important Positive Effects

	Boulder		Alameda		Platte		Total	
	#	%	#	%	#	%	#	%
Increased Ridership	2	25.0	5	33.3	17	42.5	24	38.1
Better Service to Poor and Elderly	3	37.5	6	40.0	10	25.0	19	30.2
Increased Awareness of Transit	3	37.5	2	13.3	6	15.0	11	17.5
Others	-	0 -	2	13.3	7	17.5	9	14.3
TOTAL	8	100.0	15	100.0	40	100.0	63	100.0

Most Important Negative Effects

	Boulder		Alameda		Platte		Total	
	#	%	#	%	#	%	#	%
Increase in Undesirable Passengers	9	28.1	6	19.4	16	14.0	31	17.5
Increase in Joyriding	5	15.6	2	6.5	16	14.0	23	13.0
Increase in Short Trips	5	15.6	3	9.7	10	8.8	18	10.2
Cursing, Harass Harassment	-	0 -	2	6.5	14	12.3	16	9.0
Vandalism	-	0 -	5	16	11	9.7	16	9.0
Others	13	40.6	13	41.9	47	41.2	73	41.2
TOTAL	32	100.0	31	100.0	114	100.0	177	100.0

Appendix E: Selected Summary Results of Transit User and General Household Survey Responses

LIST OF TABLES

Table E.1
WEEKDAY OFF-PEAK RIDERSHIP
TRIPS BY SOCIO-ECONOMIC CHARACTERISTICS

	A-trips	B-trips	C-trips	D-trips	E-trips
By Access to Auto					
as driver	5692.	1149.	1910.	1075.	752.
as passenger	2986.	674.	1330.	707.	475.
no access	7821.	3476.	6750.	2018.	975.
by Household Income					
under $5,000	5811.	1314.	3600.	1041.	799.
$5,000 to $9,999	3712.	1351.	2390.	1129.	693.
$10k to $14,999	2937.	995.	1700.	574.	136.
$15k to $24,999	3349.	1177.	1390.	627.	337.
$25k and more	2755.	676.	910.	429.	227.
By Age					
1 to 16 years	3564.	1089.	2350.	821.	612.
17 to 24 years	5280.	2222.	2930.	1676.	519.
25 to 44 years	5412.	1611.	2650.	927.	647.
45 to 64 years	1749.	434.	1090.	224.	319.
65 and more years	511.	137.	980.	152.	103.
by Race					
white	10791.	3556.	5640.	2554.	1162.
black	2089.	841.	2010.	657.	436.
hispanic	2046.	693.	1790.	457.	425.
other	973.	407.	560.	152.	178.

Key: A=trips from other mode. B=induced trips. C=peak to off-peak trips.
D=off-peak to peak trips. E=foregone transit trips.

Source: On-board survey (8/78 and 3/79), DCCD estimates.

Table E.1 (cont'd.)
WEEKDAY OFF-PEAK RIDERSHIP
TRIPS BY SOCIO-ECONOMIC CHARACTERISTICS

	E-trips	G-trips	H-trips
By Access to Auto			
as driver	20382.	13458.	11630.
as passenger	10772.	6761.	5581.
no access	46345.	31290.	28298.
By Household Income			
under $5,000	20382.	13496.	11656.
$5,000 to $9,999	19607.	13996.	12174.
$10k to $14,999	14415.	9493.	8782.
$15k to $24,999	13717.	8765.	7801.
$25k and more	9577.	5691.	5035.
By Age			
1 to 16 years	14725.	9154.	7722.
17 to 24 years	23172.	14935.	12740.
25 to 44 years	22785.	14685.	13111.
45 to 64 years	10850.	8120.	7576.
65 and more years	5967.	4594.	4338.
By Race			
white	50375.	34101.	30385.
black	12787.	8539.	7246.
hispanic	10075.	6408.	5546.
other	4262.	2652.	2522.

Key: F=total free fare trips. G=projected base trips. H=previous off-peak trips

A+B= new bus trips A+B+C= new off-peak bus trips
A+B+C+H= F total free fare off-peak bus trips
D+E+H=G=total base off-peak bus trips

Source: On-board survey (8/78 and 3/79), DCCO estimates.

Table E.2
WEEKDAY OFF-PEAK RIDERSHIP
PERCENTAGE DISTRIBUTION OF TRIPS BY SOCIO-ECONOMIC CHARACTERISTICS

	A-trips	B-trips	C-trips	D-trips	E-trips
by Access to Auto					
as driver	34.5	20.9	19.1	28.5	34.2
as passenger	18.1	15.9	13.5	16.6	21.5
no access	47.4	63.2	67.5	55.1	44.3
by Household Income					
under $5,000	25.1	25.9	36.0	27.4	36.3
$5,000 to $9,999	22.5	24.2	23.9	29.7	31.5
$10k to $14,999	17.8	18.1	17.0	15.1	6.2
$15k to $24,999	20.5	21.4	13.9	16.5	15.5
$25k and more	16.7	12.5	9.1	11.5	10.3
By Age					
1 to 16 years	21.6	19.8	25.5	21.6	27.8
17 to 24 years	32.0	40.4	29.3	44.1	23.6
25 to 44 years	32.8	29.3	26.5	24.4	29.4
45 to 64 years	10.6	7.9	10.9	5.9	14.5
65 and more years	3.1	2.5	9.8	4.0	4.7
By Race					
white	65.4	64.7	56.4	67.2	52.8
black	16.5	15.3	20.1	17.3	19.8
hispanic	12.4	12.6	17.9	11.5	19.3
other	5.9	7.4	5.6	4.0	8.1

Key: A=trips from other mode. B=induced trips. C=peak to off-peak trips. D=off-peak to peak trips. E=foregone transit trips.

Source: On-board survey (8/78 and 3/79), DCCD estimates.

Table E.2 (cont'd.)
WEEKDAY OFF-PEAK RIDERSHIP
PERCENTAGE DISTRIBUTION OF TRIPS BY SOCIO-ECONOMIC CHARACTERISTICS

	F-trips	G-trips	H-trips
By Access to Auto			
as driver	26.3	26.1	25.6
as passenger	13.9	13.1	12.3
no access	59.8	60.8	62.2
By Household Income			
under $5,000	26.3	26.2	25.6
$5,000 to $9,999	25.3	27.2	26.8
$10k to $14,999	18.6	18.4	19.3
$15k to $24,999	17.7	17.0	17.1
$25k and more	12.1	11.1	11.1
by Age			
1 to 16 years	19.0	17.8	17.0
17 to 24 years	29.9	29.0	28.0
25 to 44 years	29.4	28.5	28.8
45 to 64 years	14.0	15.8	16.7
65 and more years	7.7	8.9	9.5
by Race			
white	65.0	66.2	66.8
black	16.5	16.2	15.9
hispanic	13.0	12.4	12.2
other	5.5	5.1	5.1

Key: F=total free fare trips. G=projected base trips. H=previous off-peak trips.

Source: On-board survey (5/78 and 3/79), DCCD estimates.

Table E.3
WEEKDAY OFF-PEAK RIDERSHIP
GROWTH RATES OF TRIPS FOR SOCIO-ECONOMIC GROUPS

	A-trips	B-trips	C-trips	D-trips	E-trips
By Access to Auto					
as driver	42.3	8.5	14.2	-8.0	-5.6
as passenger	44.2	12.9	19.7	-10.5	-7.0
no access	25.0	11.1	21.6	-6.4	-3.1
By Household Income					
under $5,000	28.2	9.7	26.7	-7.7	-5.9
$5,000 to $9,999	26.5	9.5	17.1	-8.1	-5.0
$10k to $14,999	30.9	10.5	17.9	-6.0	-1.4
$15k to $24,999	38.2	15.4	15.9	-7.2	-3.8
$25k and more	48.4	11.9	16.0	-7.5	-4.0
By Age					
1 to 16 years	38.9	11.9	25.7	-9.0	-6.7
17 to 24 years	35.4	14.9	19.6	-11.2	-3.5
25 to 44 years	36.9	11.0	18.0	-6.3	-4.4
45 to 64 years	21.5	5.4	13.4	-2.8	-3.9
65 and more years	11.1	5.0	21.3	-3.3	-2.3
By Race					
white	31.6	10.4	16.5	-7.5	-5.4
black	32.3	10.1	24.1	-7.9	-5.2
hispanic	31.9	10.8	27.9	-6.8	-6.6
other	36.7	15.3	21.1	-5.7	-6.7

Key: A=trips from other mode. B=induced trips. C=peak to off-peak trips.
D=off-peak to peak trips. E=foregone transit trips.
Growth rate is equal to new or lost trips divided by base trips time 100.

Source: On-board survey (8/78 and 3/79), DCCD estimates.

Table E.4
WEEKDAY OFF-PEAK RIDERSHIP
ARC-ELASTICITIES BY SOCIO-ECONOMIC CHARACTERISTICS

	Unadjusted estimates	Adjusted for change in the quality of service
By access to auto		
as driver	-.205	-.270 to -.293
as passenger	-.229	-.311 to -.341
no access	-.194	-.240 to -.256
By household income		
under $5,000	-.203	-.269 to -.291
$5,000 to $9,999	-.167	-.231 to -.251
$10k to $14,999	-.206	-.242 to -.254
$15k to $24,999	-.220	-.273 to -.292
$25k and more	-.245	-.298 to -.319
By age		
1 to 16 years	-.233	-.307 to -.334
17 to 24 years	-.216	-.286 to -.311
25 to 44 years	-.216	-.267 to -.286
45 to 64 years	-.144	-.177 to -.186
65 and more years	-.130	-.158 to -.165
By race		
white	-.193	-.245 to -.263
black	-.211	-.273 to -.295
hispanic	-.223	-.286 to -.310
other	-.233	-.291 to -.314

Source: On-board survey (8/78 and 3/79), DCCD estimates.

Table E.5
REPORTED TRIP FREQUENCIES: RANDOM HOUSEHOLD SURVEYS
GENERAL POPULATION 18 YEARS OF AGE AND OLDER

Respondent One-Way Trips Per Week	Total Trips		Off-Peak Trips	
	Mean	% Once per Week+	Mean	% Once per Week+
Random 1 (10/79): Last Week	.35	8	.15	6
Random 2 (1/79): Last Week	.74	13	.40	9
Pooled (During Free Fare)	.55	10.7%	.28	7.5%*
Random 3 (5/79) (Post Free Fare)		19%		
Last Week	1.07	19%	N/A	N/A
Work/School	.77	12%	N/A	N/A
Shop	.14	5%	N/A	N/A
Other	.16	4%	N/A	N/A
Typical Week Now	1.26	23%	N/A	N/A
Typical Week During Free Fare	1.72	31%	N/A	N/A
Household Trips: Last Week				
Random 1 (10/78)	.61	14	N/A	N/A
Random 2 (1/79)	1.50	23	N/A	N/A
Pooled (During Free Fare)	1.08	19%		
Random 3 (5/79) (Post Free Fare)	1.74	25%		

N/A = Not Asked.

*Peak Trips = 5.3%

Table E.6
REPORTED TRIP FREQUENCIES: TRANSIT USER FOLLOW-UP SURVEY
PANEL OF BUS USERS DRAWN FROM ON-BOARD SURVEY (8/78)

Respondent One-Way Trips Per Week (Last Week)	Total Trips		Off-Peak Trips	
	Mean	% Once per Week+	Mean	% Once per Week+
Follow-up 1 (10/78)				
Total	3.4	58	1.5	35
Work/School	-	-	1.1	24
Shop	-	-	.3	8
Other	-	-	.2	8
Follow-up (1/79)				
Total	5.0	73	2.0	56
Work/School	4.2	43	-	-
Shop	.5	16	-	-
Other	.4	13	-	-
Pooled (During Free Fare)				
Total	4.0	64	1.7	43
Follow-up 3 (5/79)				
Total	4.4	67	1.6	27*
Work/School	-	-	1.0	17
Shop	-	-	.2	8
Other	-	-	.3	10

*Of total sample: 67% total weekly users (100%)
27% off-peak weekly users (40%)
51% peak weekly users (75%)

Appendix F
MULTI-VARIATE REGRESSION MODEL OF MONTHLY RIDERSHIP:
TOTAL RTD SCHEDULE SERVICE RIDERSHIP

The model uses unlinked RTD monthly adjusted ridership estimates as the dependent variable and has four independent variables: 1) seasonal variation as exhibited from February 1976 to January 1977; 2) a dummy variable which is equal to one if during a summer month; 3) a dummy variable which is equal to one is during the months following route-restructuring; and 4) a dummy variable denoting the first and last months of free fare. The number of variables is limited because of the small number of observations (12 months).

- The choice of the first two dummy variables is based on an analysis of the average weekday ridership. The years 1976 and 1977 showed a drop during the summer months, but the drop did not materialize during 1978.

- The second dummy variable is included to estimate the impact of route-restructuring. From the responses to the second on-board survey and the follow-up telephone surveys, it was expected that route-restructuring would show a small but significant negative impact on ridership.

- The fourth dummy variable was included after an analysis of residuals of an earlier regression which incorporated only the first three dummy variables.

The multi-variate regression model takes the form:

$$Y_1 = a_1 + a_2 D_{1i} + a_3 D_{2i} + a_4 D_{3i} + a_5 S_i + E_i$$

where D_1 = (1 if summer months; else 0)

D_2 = (1 if month affected by route-restructuring; else 0)

D_3 = (1 if first or last month of free fare; else 0)

S_i = (past seasonal variations)

E_i = stocastic term

Estimated parameter and significance values are:

$$Y^* = 1.78 + .117D_1 - .137D_2 - .205D_3 + .7635$$
$$\quad\quad (8.26)\ (3.49)\quad (4.63)\quad (6.08)\quad (9.49)$$

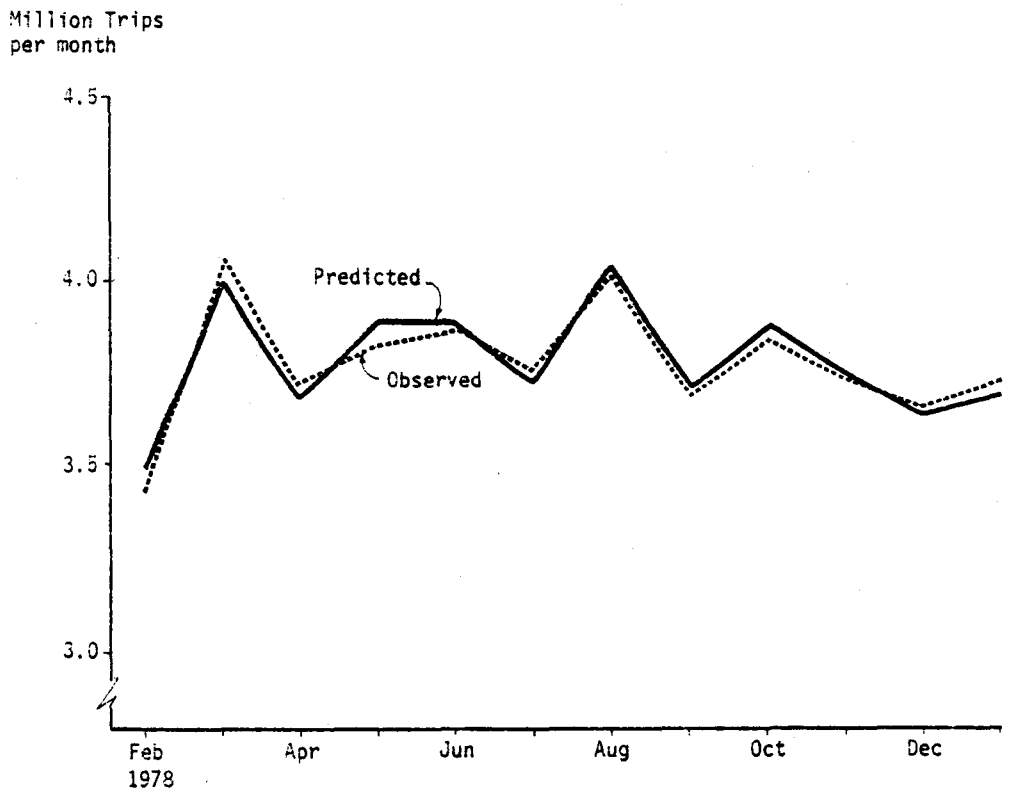
t-values in parenthesis,

$R = .96 \quad R^2 = .93 \quad F = 38.50$

Results in million units.

Figure F.1 contains a graph of the observed and predicted ridership. Estimation error is very small--on the average less than one percent.

Figure F.1
COMPARISON BETWEEN PREDICTED MONTHLY RTD RIDERSHIP AND OBSERVED



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