TECHNICAL REPORT STANDARD TITLE PAGE

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
UMTATX801059-2F		

4. Title and Subtitle	5. Report Date
ENERGY AND TEXAS TRANSPORTATION	July 1980
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
Dennis L. Christiansen	Technical Report 1059-2F
9. Performing Organization Name and Address	10. Work Unit No.
Texas Transportation Institute The Texas A&M University System College Station, Texas 77843	11. Contract or Grant No. Study No. 2-10-79-1059
12. Sponsoring Agency Name and Address	13. Type of Report and Period Covered
State Department of Highways and Public Transportation: Transportation Planning Division P. O. Box 5051 Austin, Texas 78763	Final - September 1978 July 1980
	14. Sponsoring Agency Code

15. Supplementary Notes

The study was conducted in cooperation with the Urban Mass Transportation Administration.

16. Abstract

As a result of the shortages experienced in 1974 and 1979, considerable attention has been focused on energy availability and the relationship between transportation and energy. This report complements a previous report entitled "Trends in Texas Transportation Fuel Consumption" (Technical Report 1059-1). This report addresses three major topics: 1) a relationship between the economy of Texas and Texas transportation fuel consumption; 2) quantitative data describing the magnitude of the fuel shortfalls that occurred in 1974 and 1979; and 3) potential transportation energy conservation options.

17. Key Words	18. Distribution Statement
Energy, Transportation Fuel Consumption, Transportation Energy Conservation	No restrictions. This document is available to the public through the National Technical Information Service, Springfield, Virginia 22161

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

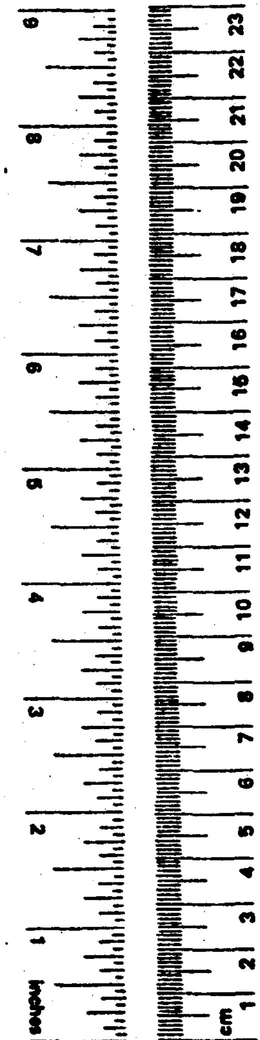
Form DOT F 1700.7 (8-69)

METRIC CONVERSION FACTORS

Approximate Conversions to Metric Measures

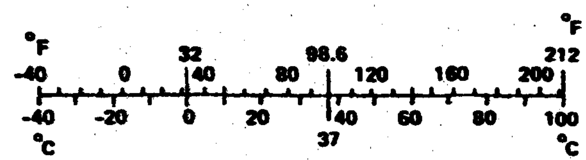
Symbol	When You Know	Multiply by	To Find	Symbol
		LENGTH		
in	inches	*2.5	centimeters	cm
ft	feet	30	centimeters	cm
yd	yards	0.9	meters	m
mi	miles	1.6	kilometers	km
		AREA		
in^2	square inches	6.5	square centimeters	cm^2
ft^2	square feet	0.09	square meters	m^2
yd^2	square yards	0.8	square meters	m^2
mi^2	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		
mm	millimeters	0.04	inches	in
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



ENERGY AND

TEXAS TRANSPORTATION

by

Dennis L. Christiansen
Study Supervisor

Edited by A.V. Fitzgerald
Assistant Research Specialist

Technical Report 1059-2F

Energy and Texas Transportation
An Analysis and Evaluation of Alternative Futures
Technical Study Number 2-10-79-1059

Sponsored by

State Department of Highways and Public Transportation
In cooperation with the
U.S. Department of Transportation
Urban Mass Transportation Administration

Texas Transportation Institute
Texas A&M University System
College Station, Texas

July 1980

The preparation of this study was financed in part through a grant from the Urban Mass Transportation Administration, United States Department of Transportation, under the Urban Mass Transportation Act of 1964, as amended.

ABSTRACT

As a result of the shortages experienced in 1974 and 1979, considerable attention has been focused on energy availability and the relationship between transportation and energy. This report complements a previous report entitled "Trends in Texas Transportation Fuel Consumption" (Technical Report 1059-1). This report addresses three major topics: 1) a relationship between the economy of Texas and Texas transportation fuel consumption; 2) quantitative data describing the magnitude of the fuel shortfalls that occurred in 1974 and 1979; and 3) potential transportation energy conservation options.

Key Words: Energy, Transportation Fuel Consumption, Transportation Energy Conservation

SUMMARY

It is generally recognized that a relationship exists between the economy of the state and the quality of the state's transportation system. Since 80% of transportation fuel in Texas is consumed by highway modes of travel, an available supply of gasoline is essential to the economy of the state. A high correlation exists between the Texas Gross State Product and indicators of travel in the state, lending at least some substantiation to the intuitive assessment that a relationship exists between transportation and the economy of the state. This suggests that substantial fuel shortages will adversely impact the economy of the state which will, in turn, reduce the demand for transportation. That occurrence may eliminate the need for imposing some conservation programs such as rationing.

During the decade of the 1970's, energy shortages occurred two times. One followed the Arab Oil Embargo (1973 to 1974), and the other occurred in 1979. The greatest monthly shortfall during both shortage periods was approximately 10%; since consumption had been growing at annual rates of about 5%, the effective shortage was in the range of 15%. Reductions in vehicle-miles of travel accounted for virtually all of this reduction in fuel consumption.

Significant opportunities exist to reduce transportation fuel consumption. It appears that, by 1997, this consumption can be reduced by over 40% below what 1997 levels would otherwise be. Virtually all of this reduction is the result of improved auto fuel efficiency and a reduction in urban trip making.

IMPLEMENTATION STATEMENT

Transportation energy availability directly affects mobility, and mobility directly affects the economy of the state. Decisions may need to be made by government concerning the manner in which limited fuel supplies will be allocated and the manner in which the transportation system may need to be altered to account for limited and more expensive fuel. At present, little is known about the interrelationships of transportation, energy, and the economy. This study is intended to develop data concerning those interrelationships that will assist in making the necessary decisions.

DISCLAIMER

TABLE OF CONTENTS

TEXAS ECONOMY AND TRANSPORTATION

Although difficult to quantify, it is generally recognized that a relationship exists between the economy of the state and the quality of the state's transportation system. As documented previously (Technical Report 1059-1), the transportation system is heavily oriented toward the highway modes of transportation; those modes use in excess of 80% of all transportation fuel consumed in the state.

The highway modes depend on a continual supply of energy; to maintain mobility and to continue to accommodate growth in the state, a supply of energy is essential. If that supply does not exist, the economy of the state can be expected to be adversely affected.

That occurrence may make some energy contingency plans unnecessary. For example, some proposed rationing plans have had a "triggering mechanism" of a 20% energy shortfall. However, if a 20% shortfall actually took place, the economic implications could well be severe. As the economic situation deteriorated, the demand for transportation and transportation energy would decline considerably without the imposition of a rationing program.

As a part of this project, at a macroscopic level, relationships between the Texas economy and the transportation system were developed. Figure 1 shows the relationship between the Texas Gross State Product (the equivalent of the Gross National Product for Texas) and the total Texas transportation bill. Figure 2 shows the relationship between the Texas Gross State Product and several indicators of transportation activity in the state. The information used to plot Figures 1 and 2 is presented in Table 1.

All relationships shown in Figures 1 and 2 show a high correlation between transportation activity and the overall economy of the state. These

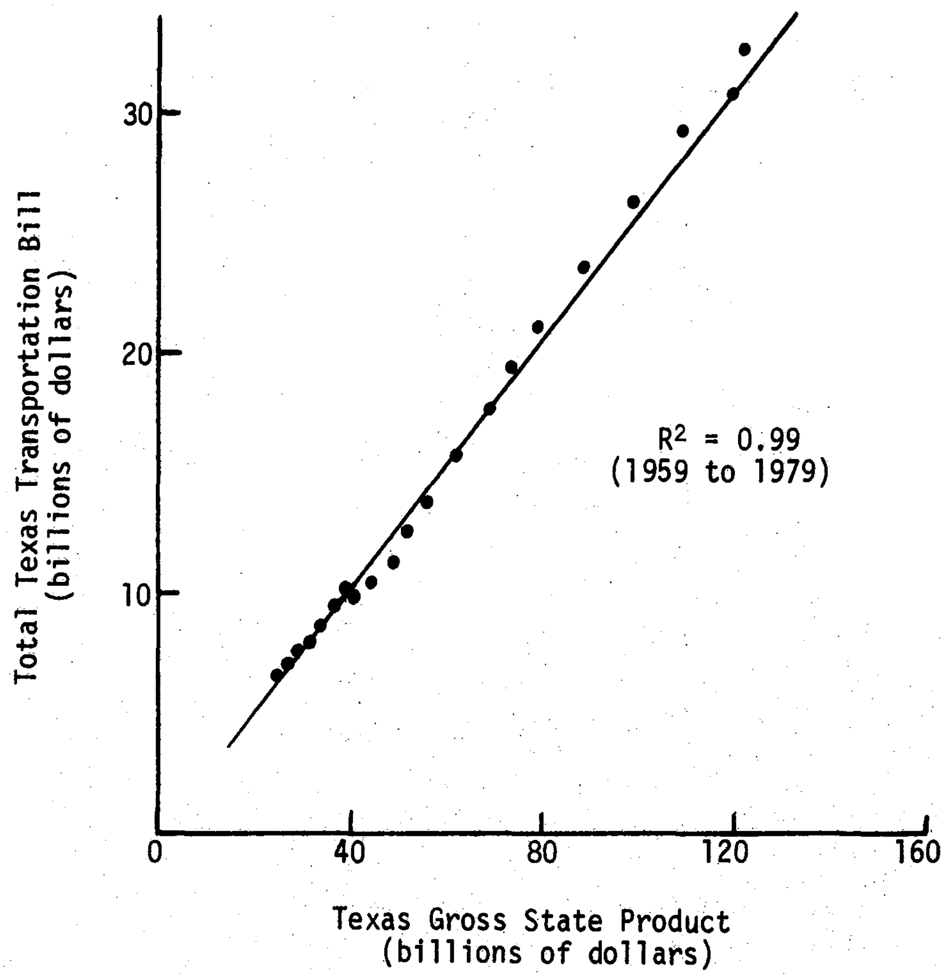


Figure 1: Relationship Between Texas Gross State Product and Total Texas Transportation Bill, 1959 to 1979

Table 1: Texas Economic and Transportation Data

Year	Texas Gross State Product (millions)	Total Texas Trans. Bill (millions)	Vehicle-Miles of Highway Travel (billions of miles)	Highway Use of Gasoline (millions of gallons)	Person Movement (Million Passenger-miles)	Goods Movement (million ton-miles)
1950	$ 14,098		26.4	2339		
1951	16,256		29.1	2465		
1952	17,102		31.3	2653		
1953	18,048		32.3	2753		
1954	18,058		33.3	2858		
1955	19,701		35.7	3080		
1956	20,750		36.6	3165		
1957	21,834		37.1	3238		
1958	22,141		38.1	3357		
1959	23,946	$ 6,399	40.7	3524		
1960	24,680	6,397	41.3	3547		
1961	25,785	6,503	43.6	3673		
1962	27,314	6,982	44.6	3817		
1963	28,811	7,555	47.1	3996		
1964	30,948	7,961	48.6	4235		
1965	33,495	8,543	53.0	4396		
1966	36,923	9,390	56.4	4607		
1967	40,089	9,761	59.0	4817		
1968	44,213	10,386	62.2	5186		
1969	48,377	11,206	64.3	5534		
1970	51,465	12,456	68.0	5841	122,053	178,687
1971	55,760	13,712	71.9	6192	125,344	184,765
1972	62,437	15,724	76.6	6694	133,345	191,825
1973	68,976	17,694	80.6	7112	141,216	198,762
1974	72,440	19,348	78.7	6885	147,733	204,655
1975	78,848	21,067	84.6	7261	154,702	210,548
1976	88,405	23,520	92.0	7735	164,767	218,897
1977	98,134	26,202	99.3	8175	174,768	228,965
1978	109,580	29,258	102.6	8472	186,576	240,077
1979	122,018	32,578	101.8	8165		

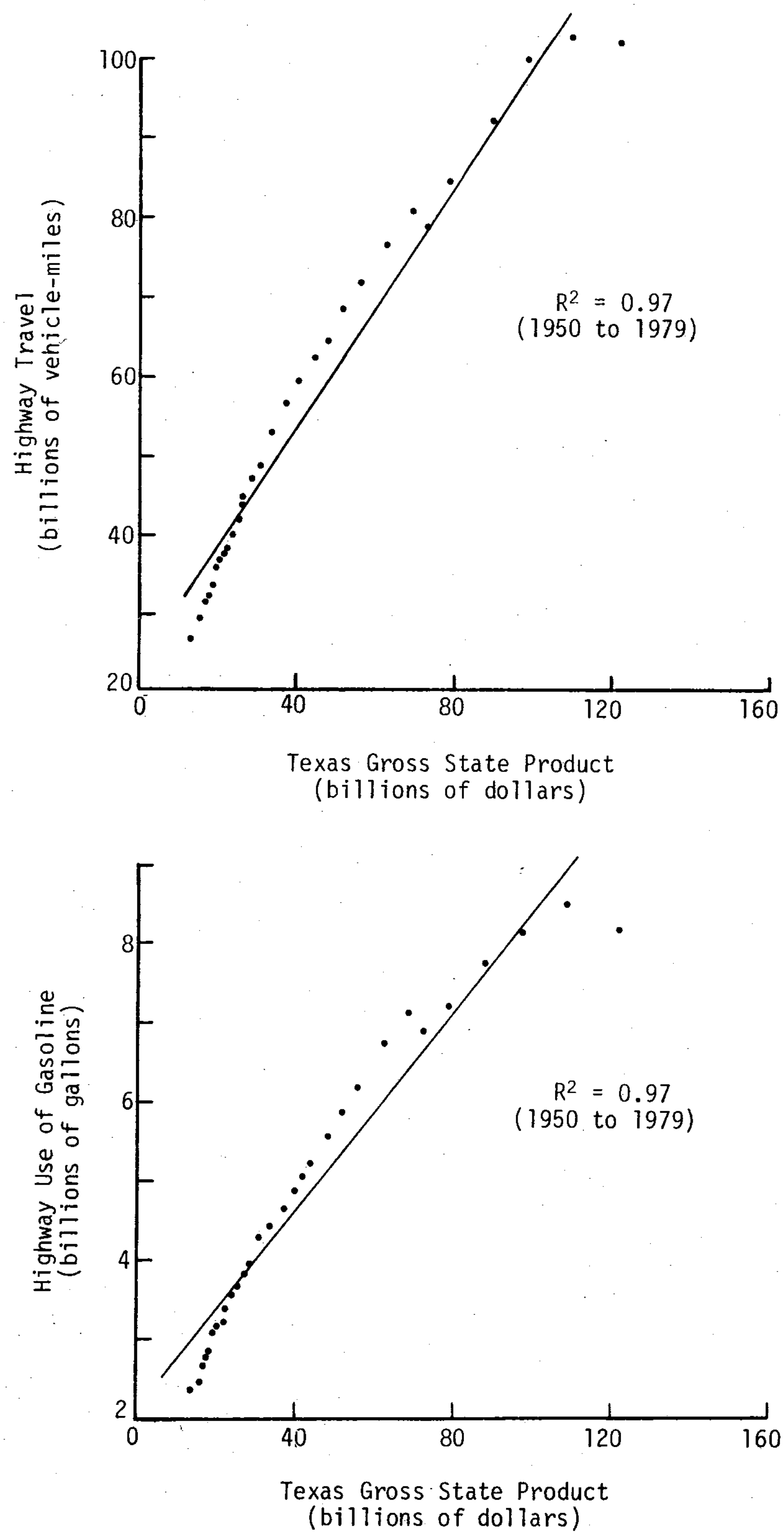


Figure 2: Indicators of the Relationship Between the Economy and the Transportation System in Texas

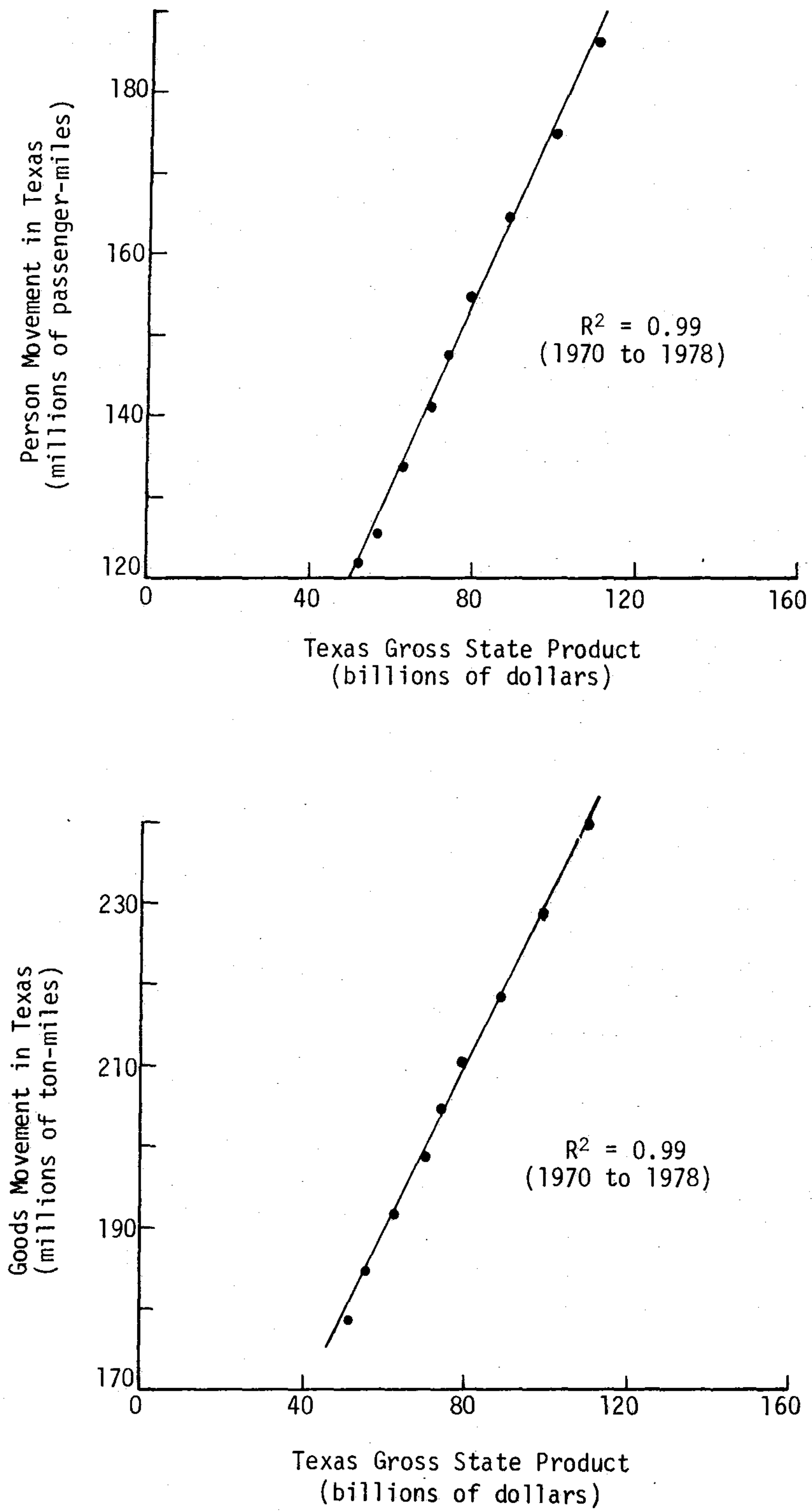


Figure 2: (Continued)

macroscopic relationships do not conclusively show a causal relationship (e.g., both the Gross State Product and the transportation activity indicators show some correlation to a third variable, population). However, the figures do lend some substantiation to the intuitive assessment that the economy of the state and the transportation system of the state are highly interrelated.

During the analysis periods, the Texas Gross State Product increased every year. With the exception of two years, 1974 and 1979, all transportation activity indicators also increased every year. The decreases that occurred in 1974 and 1979 did not exceed 4% (refer to the subsequent section of this report). It is assumed that, if shortfalls in the magnitude of 20% occurred and lasted for a sufficiently long time to permit start-up of a rationing program, the economy of the state would be greatly affected. The impact on the economy would, in turn, greatly reduce the demand for transportation and transportation fuel which would greatly lessen the need for expensive and possibly unmanageable transportation energy conservation programs.

ENERGY SHORTAGES IN TEXAS

Since data were first collected in the 1920's, the demand for highway motor fuel in Texas has only decreased in 5 of those years (1932, 1942, 1943, 1974, and 1979). Available consumption data for Texas from 1925 to 1977 were presented in Technical Report 1059-1. Updated information for the decade of the 1970's is presented in Table 2 and Figure 3.

Table 2: Highway Motor Fuel Consumption in Texas, 1970-1979

Total Motor Fuel Consumption			Gasoline		Special Fuels	
Year	Millions of Gallons	Percent Increase	Millions of Gallons	Percent Increase	Millions of Gallons	Percent Increase
1970	6294	-	5841	-	453.0	-
1971	6715	6.7	6192	6.0	522.8	15.4
1972	7290	8.6	6694	8.1	596.4	14.1
1973	7821	7.3	7112	6.2	709.1	18.9
1974	7593	(2.9)	6885	(3.2)	707.4	(0.2)
1975	8006	5.4	7261	5.5	745.3	5.4
1976	8564	7.0	7735	6.5	829.1	11.2
1977	9129	6.6	8175	5.7	953.4	15.0
1978	9548	4.6	8472	3.6	1075.6	12.8
1979	9470	(0.8)	8165	(3.6)	1305.5	21.4

Source: State Department of Highways and Public Transportation

During the past decade, two periods of noticeable energy shortages occurred. One followed the Arab Oil Embargo in late 1973, and the other became apparent in the summer of 1979. Since the first of these shortages was a major reason for funding this technical study effort, it appears appropriate to provide quantitative documentation of the magnitude of the gasoline

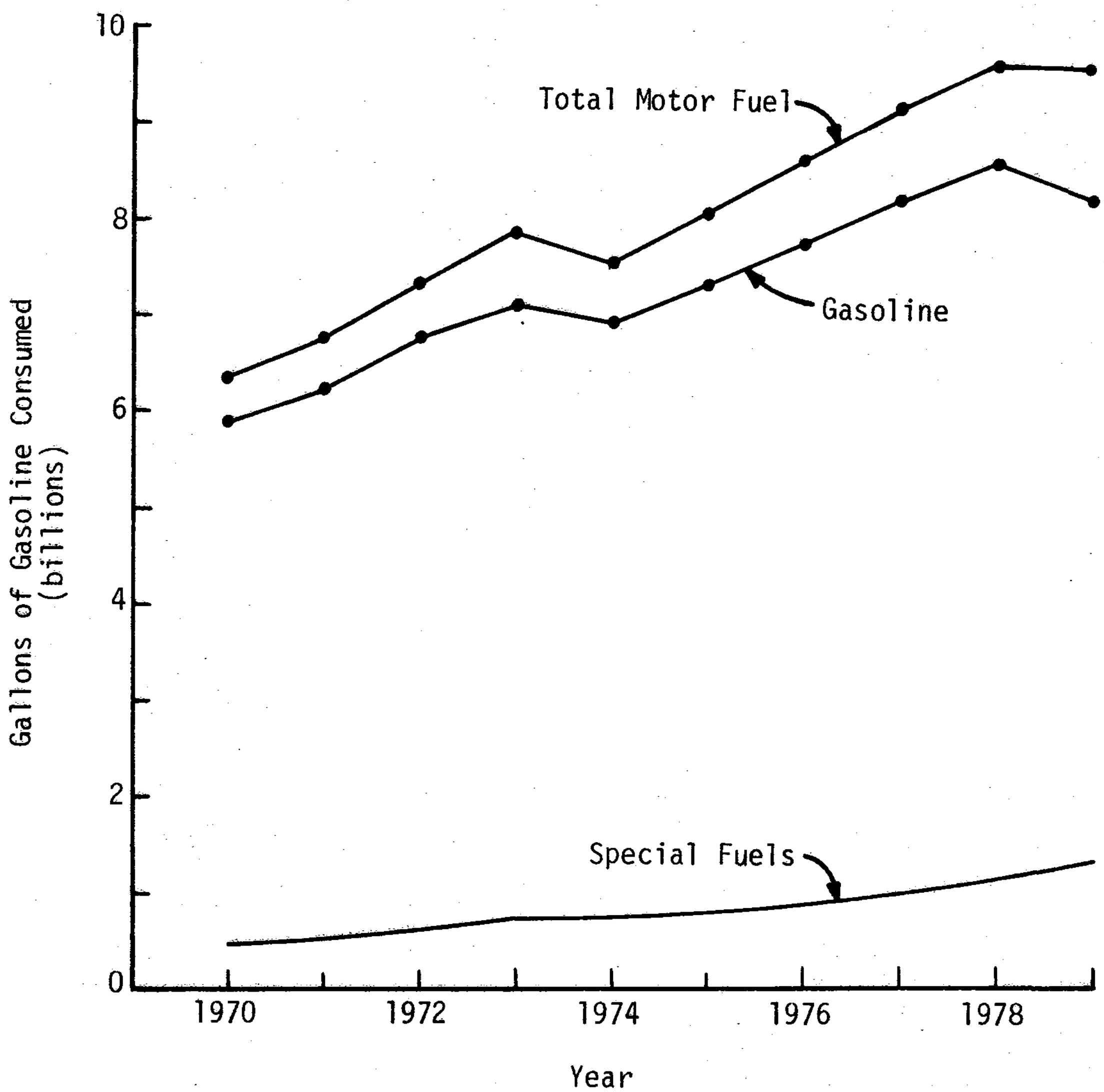


Figure 3: Highway Motor Fuel Consumption in Texas, 1970 to 1979

shortages. In this report, data routinely collected by the State Department of Highways and Public Transportation are used to provide this documentation. Table 2 and Figure 3 show the information on an annual basis; the annual reduction in gasoline consumed never exceeded 3.6%.

The numbers given previously in this section represent annual usage; as such, they do not reflect the greatest monthly shortfall that occurred during the time periods being considered. Table 3 presents data pertaining to the greatest monthly shortfall.

Table 3: Greatest Monthly Shortfall in Texas Gasoline Consumption During the Two Energy Shortages

Consumption Factor	Time Period	
	February 1973 to 1974	May 1978 to 1979
% Change in Gasoline Consumption	-10.2%	-11.4%
Magnitude of Reduced Consumption (thousands of gallons)	57,000	88,000

In terms of percentage reduction, the two shortages were essentially equivalent. In that gasoline consumption had historically been increasing at about 5% per year (Table 2), the effective shortage is really about 15% to 16%; that is, had a shortage not occurred, consumption in 1974 would have been expected to exceed 1973 consumption, and 1979 consumption would have been expected to exceed that of 1978.

The shortfall, expressed in gallons, for the 1978-79 period is over 50% greater than that for the 1973-74 period. Even though the percentage changes are similar, this happened for 2 reasons. First, May is typically a higher fuel consumption month than is February and, second, total fuel consumption for the 1978-79 analysis period was noticeably greater than for the 1973-74 analysis period.

One final way to look at the two shortages is to express consumption on a per capita basis (Figure 4). For the time period shown in that figure, from 1973 to 1974, per capita consumption decreased by about 5%; then, in spite of conservation efforts, per capita consumption began to increase at a rate of approximately 3.3% per year (1974-78 time period). Per capita 1979 consumption was 5.5% below 1978 levels; the 1979 consumption level per capita is approximately 2% above the 1973 consumption level and is 7.7% above the 1974 level.

The reduction in gasoline consumption is primarily the result of a reduction in vehicle miles of travel. Some of the reduction is due to increased fleet efficiency. Some slight increases (5%) in vehicle occupancy have been recorded; transit systems have experienced ridership increases. Table 4 provides an estimate of the factors accounting for the reduced gasoline consumption.

Previous work performed by TTI has suggested that transportation energy consumption could be reduced by 10% to 15% without resulting in drastic economic implications. Economic growth in the state during the analysis periods tends to substantiate that finding.

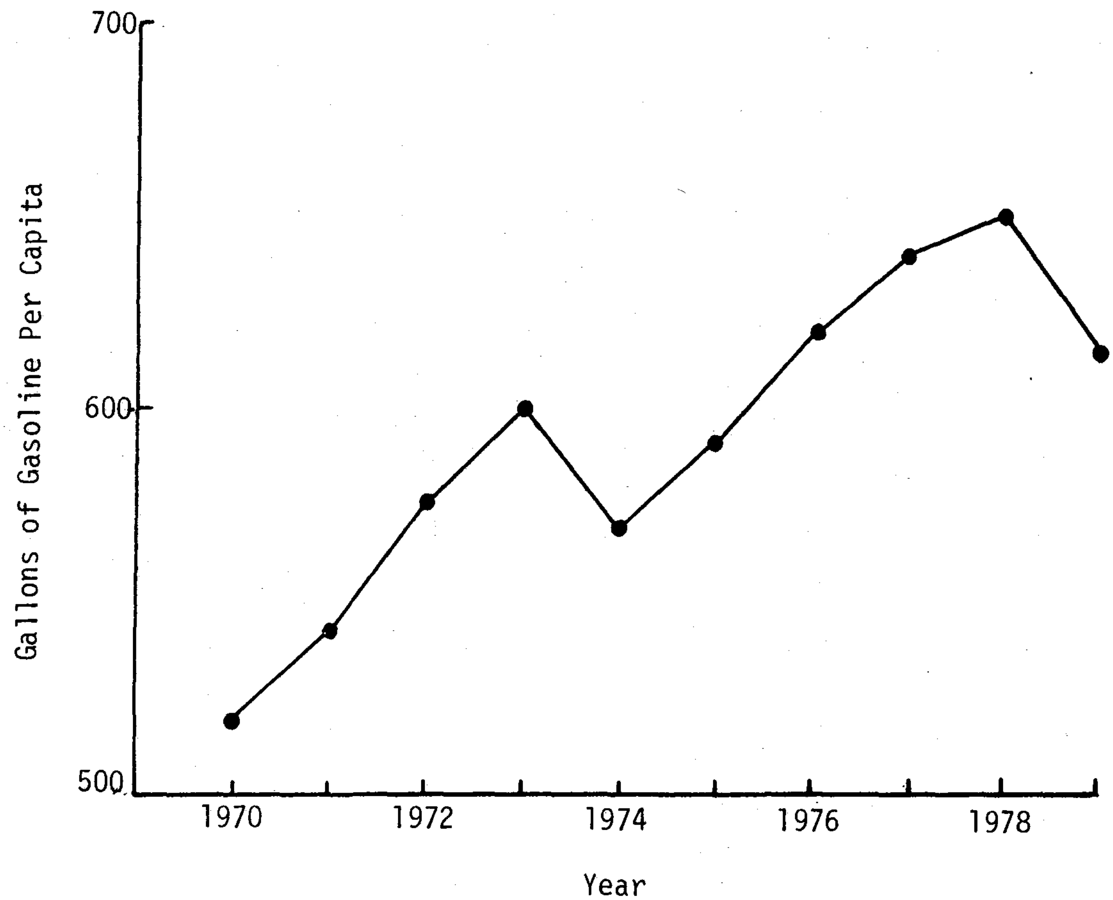


Figure 4: Gasoline Consumption Per Capita in Texas, 1970 to 1979

Table 4: Preliminary Estimate of Factors Accounting For Reduction in Gasoline Consumption During Periods of Energy Shortage

Factor	% of Total Reduction Attributed To
Reduced Vehicle Miles of Travel	>90
Increased Fleet Efficiency	< 5
Increased Occupancy, Transit Utilization, etc.	< 5
Total	100

ENERGY CONSERVATION ALTERNATIVES

The data presented previously suggest that the transportation system has considerable "flexibility" to respond to energy shortages at least in the short-term. Effective monthly shortfalls in the range of 15% have been realized in both 1974 and 1979; vehicle-miles of travel were reduced during those time periods as the principal means of response to the shortfall. Thus, short-term shortfalls in the range of 10% to 15% can be dealt with by the system with little or no "imposed" government conservation measures. This is in general agreement with previous TTI research that has estimated that an urban family could "easily" reduce their trip-making by one trip per day, or about 10% to 12%. Such changes in trip-making can be accomplished with minimal socioeconomic impact.

Gasoline price also has become a factor that is suppressing the demand for fuel. Although the true elasticity of demand for gasoline is not known, most estimates place it at about 0.1; that is, for each 10% increase in the real price of gasoline, a 1% decrease in consumption can be expected. Rapid increases in gasoline price are assumed to be the major reason that consumption in the first third of 1980 is below 1979 levels, in spite of the fact that fuel has been available in 1980. The increased price has caused at least some of the "unnecessary" travel to be curtailed. This occurrence may have lessened some of the response capability of the transportation system; since discretionary travel has been curtailed for reasons of price, less of that travel can be curtailed in response to energy shortfall situations.

Urban Travel Characteristics

In assessing the effectiveness and the impact of various alternative energy conservation measures, quantitative data pertaining to Texas travel patterns are desirable. As shown in Technical Report 1059-1, most transportation fuel consumption is by the automobile, particularly travelling in urban areas. Tables 5 and 6 document certain Texas travel data.

Many fuel conservation efforts are oriented toward the urban work trip. Average trip lengths for the work trip are approximately 50% greater than the overall average trip length.

Table 5: Weekday Travel Characteristics in Texas Urban Areas

Characteristic	Large Urban Areas (Population > 175,000)	Small Urban Areas (Population < 175,000)
Average Daily Auto Trips/Dwelling Unit (one-way)	7.2 trips	8.7 trips
Average Trip Length	5.0 miles	2.3 miles
Average Daily Auto Miles/Dwelling Unit	36.0 miles	20.0 miles
Average Daily Auto Trips/Auto (one-way)	5.4 trips	6.1 trips
Average Daily Auto Miles/Auto	26.9 miles	14.1 miles
Average Weekly Auto Miles/Auto	134.3 miles	71.0 miles

Source: Fuel Conservation Measures: The Transportation Sector. Prepared By Texas Transportation Institute, January 1975.

Table 6: Average Weekly Travel By Trip Purpose, Texas Urban Areas

Purpose for Travel	Average Weekly Travel (Monday-Friday)			
	Large Urban Areas		Small Urban Areas	
	Auto-Miles/ Dwelling Unit	Auto-Miles/ Auto	Auto-Miles/ Dwelling Unit	Auto-Miles/ Auto
Work	82.1	61.2	37.0	26.0
Personal Business	23.7	17.7	14.5	10.3
Shopping	36.5	27.3	22.5	15.8
School	4.9	3.6	3.3	2.3
Medical-Dental	2.7	2.0	1.1	0.8
Social-Recreational	20.2	15.1	13.3	9.4
Eat-Meal	9.9	7.4	8.3	5.9
All Purposes	180.0	134.3	100.0	70.5

Source: Fuel Conservation Measures: The Transportation Sector. Prepared By Texas Transportation Institute, January 1975.

Conservation Potential of Various Transportation Measures

This section quantifies the potential conservation impact of different transportation measures. Table 7 provides a summary of the effectiveness of various transportation policies designed to reduce fuel consumption. Two things are evident from that table. First, if anticipated increases in auto efficiency are successfully attained, approximately 65% of the total "potential" improvement in transportation fuel conservation will have been realized. Second, there are relatively few significant conservation efforts that can be initiated and pursued at the state level. It appears that state involvement may center more around the equity of various measures such as fuel allocation rather than the implemention of major conservation measures.

Table 7: Summary, Effectiveness of Policies Designed to Reduce Transportation Fuel Consumption

Type of Travel and Policy	Maximum Percent Reduction in Total Transportation Fuel Consumption [1]		Dates Associated With Policies		Governmental Unit Primarily Responsible For Policy Promotion
			Implementation	Maximum Effectiveness	
Person Movement					
Urban					
Reduced Trip Making		8.0	1979	1980	-
Improved Auto Efficiency		16.7	1978	1997	Federal
Mass Transit Improvements		1.8	1980	1995	Federal, State, Local
Other Conservation Measures [2]		6.0	1980	1990	Local
Combined Impact [3]		26	1978	1997	-
Intercity					
Improvement Auto Efficiency		9.9	1978	1997	Federal
Inc. Airline Load Factors		1.1	1978	1983	Federal, State
Modal Shifts		0.6	1980	1985	Federal
Combined Impact [3]		11	1978	1997	-
Total Potential Savings	37		1978	1997	-
Goods Movement					
Urban					
Increased Load Factors		0.8	1980	1985	Local
Intercity					
Improved Diesel Efficiency		1.0	1980	1995	Federal
Regulatory Changes		2.0	1980	1985	Federal, State
Modal Shift		0.2	1980	1985	Federal, State
Combined Impact [3]		3	1980	1995	-
Total Potential Savings	4		1980	1995	-
All Transportation	41		1978	1997	-

[1]Many measures apply only to gasoline consumption. Gasoline consumption represents about 75% of total statewide transportation fuel consumption. Urban gasoline consumption represents about 60% of total gasoline consumption (refer to Technical Report 1059-1).

[2]Other measures include carpooling/vanpooling, bicycling/walking, and improved traffic flow.

[3]All conservation measures are not compatible. Thus, the potential savings associated with the individual measures are not additive in determining total savings.

Most of the conservation potential shown in Table 7 is the result of either improved auto efficiency or changes in urban person movement. A discussion of those conservation techniques is presented in this section. The data and analyses used to estimate the other conservation impacts have been documented in previous TTI reports ("Fuel Conservation Measures: The Transportation Sector," two volumes).

In recent years considerable discussion has been given to gasoline rationing. Some of the impacts of proposed rationing plans, as they relate to Texas travel, are documented in subsequent parts of this report.

Reduced Urban Travel

Tables 5 and 6 presented data describing existing urban travel patterns in Texas. The "average" urban household in Texas currently makes about 8 one-way auto trips per day; at least some of these are unorganized, disjointed trips. Careful trip planning, which is encouraged by high gasoline prices or restricted availability, can reduce the number of trips made by the typical household.

It is assumed that each household could reduce travel by one trip per day without causing any major inconveniences. Such a reduction in urban gasoline consumption would result in approximately an 8% reduction in total statewide transportation fuel consumption.

Improved Auto Fuel Efficiency

As shown in Technical Report 1059-1, the automobile, in both urban and intercity travel, utilizes about 75% of total transportation energy consumed in Texas. Thus, increases in the average fuel efficiency attained by the auto fleet can significantly reduce fuel consumption.

Beginning with the 1978 model year, the federal government has imposed fuel efficiency standards on the auto industry (refer to Technical Report 1059-1). Fuel economy must increase at least until 1985; what happens after 1985 is still uncertain. Recognizing that it takes approximately 12 years for the fleet to turn over, and that actual fuel economy on the road is approximately 20% less than the standards, Figure 5 shows what can be expected to happen to the fuel efficiency of the fleet operating on Texas roadways. Fuel efficiency can be expected to increase from 14.1 mpg in 1980 to 18.2 mpg in 1990, an increase of nearly 30%. The 1990 fuel economy values represent a 38% improvement over the low fuel economy value obtained in 1973 (13.2 mpg). Based on existing standards, by 1997 an average fleet fuel economy of 22 mpg would exist, representing a 56% improvement over 1980 fuel economy levels.

Improving auto fuel efficiency by 56% would reduce total transportation fuel consumption by 26.6%; of that, 16.7% would be the result of urban travel and 9.9% the result of intercity travel. The policy initiated to obtain those savings began in 1978; it will achieve its maximum effectiveness in 1997. The federal government has assumed the lead in the conservation effort.

Mass Transportation Improvements

Increased use of public transportation is a means of reducing reliance upon the private auto. However, in the near future, public transportation systems, which operate in only 18 Texas cities, have very limited capacity for serving additional trips. In the cities with transit systems, those systems serve less than 5% of total urban trips; 50% of the trips served by transit occur in the peak hours, and 60% of the trips served by transit are for work purposes. As a result, in the short term, since peak-period loads are already near capacity, it is estimated that transit ridership can be

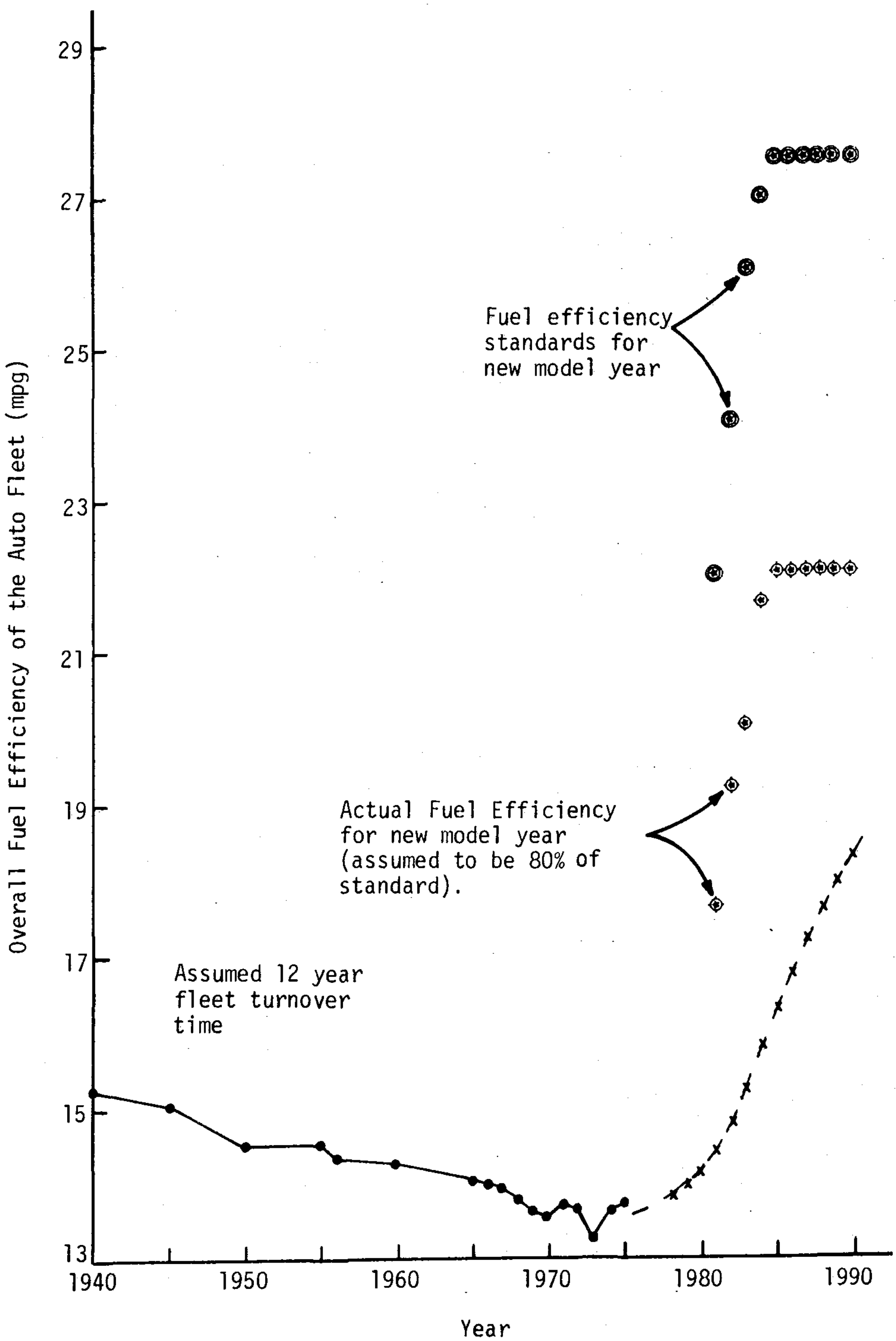


Figure 5: Trends in Texas Auto Fleet Fuel Efficiency

increased by no more than 20%. That would reduce statewide transportation fuel consumption by about 1%.

In the longer run, it would be possible to purchase additional equipment and expand service. However, it is unlikely that transit would ever serve more than 15% of total urban trips in all Texas urban areas; that represents a tripling of current usage on existing systems plus instituting numerous new transit systems. That level of transit usage would reduce total statewide transportation fuel consumption by about 1.8%.

It is important to note that public transit is best suited for serving travel to and from concentrated activity centers such as the downtown. Realistically, transit could never be expected to serve the variety of disjointed, dispersed trips that occur daily in accordance with the lifestyle to which the urban Texan has become accustomed. If public transportation were proposed as a means of providing transportation for these many trip purposes, it is entirely conceivable that more fuel would be consumed than is now being consumed by the auto in serving those trips.

Other Urban Transportation Conservation Measures

A variety of other techniques -- including car- and vanpooling, staggered work hours, increased bicycling and walking, and traffic engineering improvements -- can be pursued to reduce transportation fuel consumption. The combined effect of pursuing all of these approaches might be a reduction in transportation fuel consumption of about 6%.

Carpooling and Vanpooling

Vanpooling has increased rapidly in Texas in recent years. In April of 1980, nearly 1400 vanpools were in operation in urban areas in the state.

Their operations saved an estimated 6 million gallons of fuel per year. That savings, although impressive, represents only 0.06% of annual statewide transportation fuel consumption. However, vanpooling programs are growing rapidly; it is perhaps not unreasonable to expect that the current program could expand by a factor of as much as 25 in the next 10 years. Such an expansion would result in vanpools saving perhaps 1.5% of statewide transportation fuel consumption.

While vanpools tend to serve the long-distance (20 miles) work trips, carpools provide a means of reducing auto trips for the shorter urban trips. A relatively limited number of urban trips are conducive to carpooling, those trips being primarily work trips that either originate or terminate at home, with the other trip end being in an area of concentrated activity. This represents roughly 5.6% of total urban trips. Doubling the occupancy for those trips would result in a 2.3% reduction in total statewide transportation fuel consumption.

Vanpooling and carpooling combined might be able to reduce fuel consumption by 3.8% if aggressively pursued. Increasing fuel prices will encourage the formation of such pools. Due to the somewhat limited availability of transit, carpooling and vanpooling may represent a major response to increasing energy prices.

Staggered Work Hours

Staggering work hours is designed to spread peak travel demand over a longer period of time, thereby reducing the intensity of congestion and, possibly, allowing more trips to be served by the available transit fleet. If transit were able to double existing peak-period ridership through a staggered hours program, statewide transportation fuel consumption would be reduced by less than 1%. It is somewhat doubtful whether staggered hours would double transit patronage; indeed, if staggered hours reduced congestion it is conceivable that some current transit patrons would begin to use their automobiles.

Bicycling and Walking

For certain short-distance trips, walking and/or bicycling might be used in lieu of the automobile. Walking might be an alternative for trips of less than one-third mile in length; bicycling could serve some trips of about 2 miles or less in length.

A number of factors restrict the potential of these modes of travel. Their attractiveness is affected by age, physical condition, attitude, weather, time of day, and bicycle ownership. Of total urban vehicle-miles of travel, 15.4% are made by trips of two miles or less. It is assumed that 20% of those those vehicle-miles might be served by walking/bicycling travel. Thus, increased use of bicycling/walking might reduce statewide transportation fuel consumption by 1.5%.

Traffic Engineering Improvements

Traffic operations could be improved to allow vehicles to operate at more fuel efficient speeds and to eliminate unnecessary speed changes in the traffic stream. Improvements such as freeway metering and control and progressive signalization systems might result in a savings of about 2% in statewide transportation fuel consumption. Many of these improvements would be costly to implement, and implementation could require several years.

Gasoline Rationing

For the past several months, the federal government has unsuccessfully tried to develop a gasoline rationing program. Current proposals indicate that a 20% shortfall in fuel supplies would "trigger" a rationing program that would then take several months to implement. As indicated previously, a 20% shortfall for an extended period of time will depress the economy which will, in turn, depress transportation demand without imposition of a rationing program.

The most recent rationing proposals suggest that fuel will be rationed on a per vehicle basis. The amount of fuel rationed per vehicle is, of course, a function of the extent of the shortfall. If a 20% shortfall occurred each vehicle might be rationed 70% of its previous consumption rate, 10% being held in reserve for allocation by various governmental units. A "typical" Texas vehicle in 1978 consumed 16.8 gallons per week. A rationing program based on previous consumption rates is more equitable to highly auto-oriented states such as Texas. As shown in Technical Report 1059-1, per vehicle gasoline consumption in Texas exceeds the national average by 17%.

Impact on Rural Areas

Approximately 20% of Texans reside in rural areas. Available travel data suggest that rural travel per vehicle is not greatly different from urban travel patterns; each vehicle travels approximately 200 miles per week, and each household travels about 280 miles per week.

If each vehicle were allowed 11.8 gallons (70% of the 16.8 gallon 1978 consumption rate), each vehicle would be able to travel about 165 miles (assuming 14 mpg), or 82% of the present 200-mile travel pattern per vehicle. For families with more than one vehicle, the ability to travel 330 miles would not require major alternation in travel patterns. One-car families would be more affected.

Also, as was shown previously, trip reduction per family in urban areas should not be overly difficult. However, rural families are probably making fewer total trips, and longer and better organized trips. As a result, reducing travel may be more difficult for rural residents.

Impact On Urban Areas

Tables 5 and 6 describe typical urban travel patterns in Texas. It might be instructive to view proposed rationing plans in the two manners. First, what is the minimum fuel per dwelling unit required. Second, assuming that the work trip must continue to be made and that, in general, transit alternatives do not exist, what amount of fuel is needed simply to serve the work trip.

Austerity Conditions

In estimating the minimum fuel requirements per dwelling unit, the following assumptions have been made.

- Auto-miles of travel for work purposes may be cut in half by use of carpooling and transit.
- Auto-miles of travel for personal business can be cut in half by careful planning and by the use of carpooling and transit.
- The average urban family would limit shopping travel to one grocery shopping trip per week and one other shopping trip per month per automobile.
- Auto-miles of travel for school, social-recreational, and eat-meal purposes will be completely eliminated.
- Medical-dental will continue with only slight reductions for transit usage.

Under these austerity assumptions, the average family in large urban areas would still need to travel about 68 miles per week, or about 38% of current weekday travel. The average family in small urban areas would still need to travel about 33 miles per week which represents about 47% of their current weekday travel. Using a 12 mpg assumption, for urban trips this suggests that the minimum allocation to the average family in large urban areas should be 5.7 gallons and 2.8 gallons for families in small urban areas.

In essence, an 11.8 gallon per week per vehicle allocation in large urban areas would provide the average family (1.4 autos) with 10.8 gallons per week more than that required by these austerity assumptions. If the average family were limited to 11 gallons per week per vehicle and wanted (or needed) to make a 200-mile intercity trip (i.e., a 400-mile round trip), they would have to limit their activities to austerity conditions for approximately three weeks in order to save enough gasoline for such a trip (assuming 14 mpg for intercity travel).

Impact on the Work Trip

Work travel is one of the more essential trips and, alone, represents considerable travel (Tables 5 and 6). Assuming that the typical family would have 1.4 vehicles, would get 11 gallons per week per vehicle, and would average 12 mpg, the typical urban family would be able to travel 180 miles per week. In larger urban areas, work travel alone would require 72 miles per week, or 40% of the total weekly travel allowance.

The impact of alternative rationing schemes on work travel is shown in Table 8. At present, a family in a large urban area is using approximately 32% of total weekly (7-day week) fuel for serving work trips.

Table 8: Effect of Various Rationing Schemes On Fuel Availability For the Work Trip

Gasoline/Week/Vehicle	Percent of Total Fuel Used For Work Trip[1]	
	Large Urban Areas	Small Urban Areas
5 gallons	86%	35%
7.5 gallons	57%	23%
10 gallons	43%	17%

[1]Assumes 1.4 vehicles per dwelling unit and 12 mpg.

CONCLUSIONS

This report complements a previous report entitled "Trends in Texas Transportation Fuel Consumption" (Report 1059-1). Major conclusions developed in this report include those listed below.

- The economy of the state and the transportation system of the state are interrelated. Major declines in fuel availability will adversely impact the economy which, in turn, will reduce the demand for transportation.
- Maximum monthly shortfalls in the range of 10% were experienced in both 1974 and 1979. Almost all of the shortfall was accounted for by reduced vehicle-miles of travel.
- Considerable conservation can be achieved in the transportation sector. Almost all of this conservation potential is the result of increased auto fuel efficiency and a reduction in urban trip making.