

**Fort Collins LUTRAQ Team**  
**VMT Reduction Project**

## **Estimation of VMT and VMT growth rate**

**June 22, 2001**

### **Summary**

The number of daily vehicle miles traveled (VMT) in the Fort Collins area is an important factor affecting land use, transportation, and air quality programs. Yet it cannot be measured directly, but only estimated. This report reviews three methods to estimate VMT, based on traffic modeling, traffic counts, and fuel use.

Traffic modeling, calibrated using traffic counts, is found to be the best method to estimate both VMT and the VMT growth rate. The reporting frequency should be every two years. Resources have been requested in the 2002-03 budget process that would support a traffic-model-based VMT estimate on a continuing basis.

The best estimate of the compound annual growth rate of VMT between 1990 to 1998 is found to be 4.9%. The best estimate for 2000 is 3,080,000 daily vehicle miles traveled. It is intended that these estimates be updated regularly and used consistently by various City Departments and programs.

The City Plan Monitoring Project tracks, among other “trigger” indicators, the ratio of the VMT growth rate to the Population growth rate. We find that this ratio is 1.7:1. Therefore VMT is growing faster than population, and the indicator is “triggered.”

### **Introduction**

The measurement of VMT is central to the mission of the LUTRAQ team. That is, “to develop a comprehensive program to reduce the annual rate of growth of total daily vehicle miles traveled, so that it does not exceed the rate of growth in population and employment, and see that it is carried out.” VMT has always been a difficult indicator because it is not measured directly, rather it is always estimated. This report describes three ways to estimate VMT — based on traffic modeling, based on traffic counts, and based on fuel-use.

City Plan air quality objectives not only call for reduction in VMT growth but also stipulates the measurement method: “VMT is calculated using the MINUTP traffic simulation model or equivalent, calibrated using traffic count data.” Traffic modeling, however, has not been a consistent source of VMT information. Calibrated model runs have been done at least three years apart in order to update the Regional Transportation Plan. The LUTRAQ Team therefore decided to explore other estimation techniques to supplement traffic modeling, in order to gain confidence in the estimates and to increase the frequency of reporting.

This report has several purposes:

- To summarize VMT estimates from 1990 to the present.
- To provide estimates of both current VMT and the VMT growth rate which would be used consistently by City staff in various departments and programs.
- To determine whether VMT is growing faster than population, which is a “trigger indicator” in the City Plan Monitoring Project.
- To provide for a regular update of the VMT and VMT growth estimates.

## Method 1 – Transportation modeling

Traffic models simulate the amount of traffic on each roadway, taking into account housing patterns, employment patterns, and roadway capacity. The calibration process adjusts the simulation so that it reproduces the traffic levels actually occurring. Total VMT is then calculated by adding up the VMT contribution of each roadway.

Eric Bracke, John Daggett, and Brian Woodruff drafted this report for the LUTRAQ Team. The three of us are in agreement that the best way to estimate VMT, or VMT growth, is using traffic model runs that have been calibrated to ground counts. This methodology was also used in the Mobility Report Card prepared for the North Front Range Transportation and Air Quality Planning Council (NFR) for the years 1995 and 1998.

During the 1990’s the NFR did calibrated model runs for the base years of three Regional Transportation Plans (RTP). The model domain is the “urbanized area,” similar to the Community Growth Area. Please see Attachment 1 for details. The following table provides the basic data.

**Regional Transportation Plan base-year model**

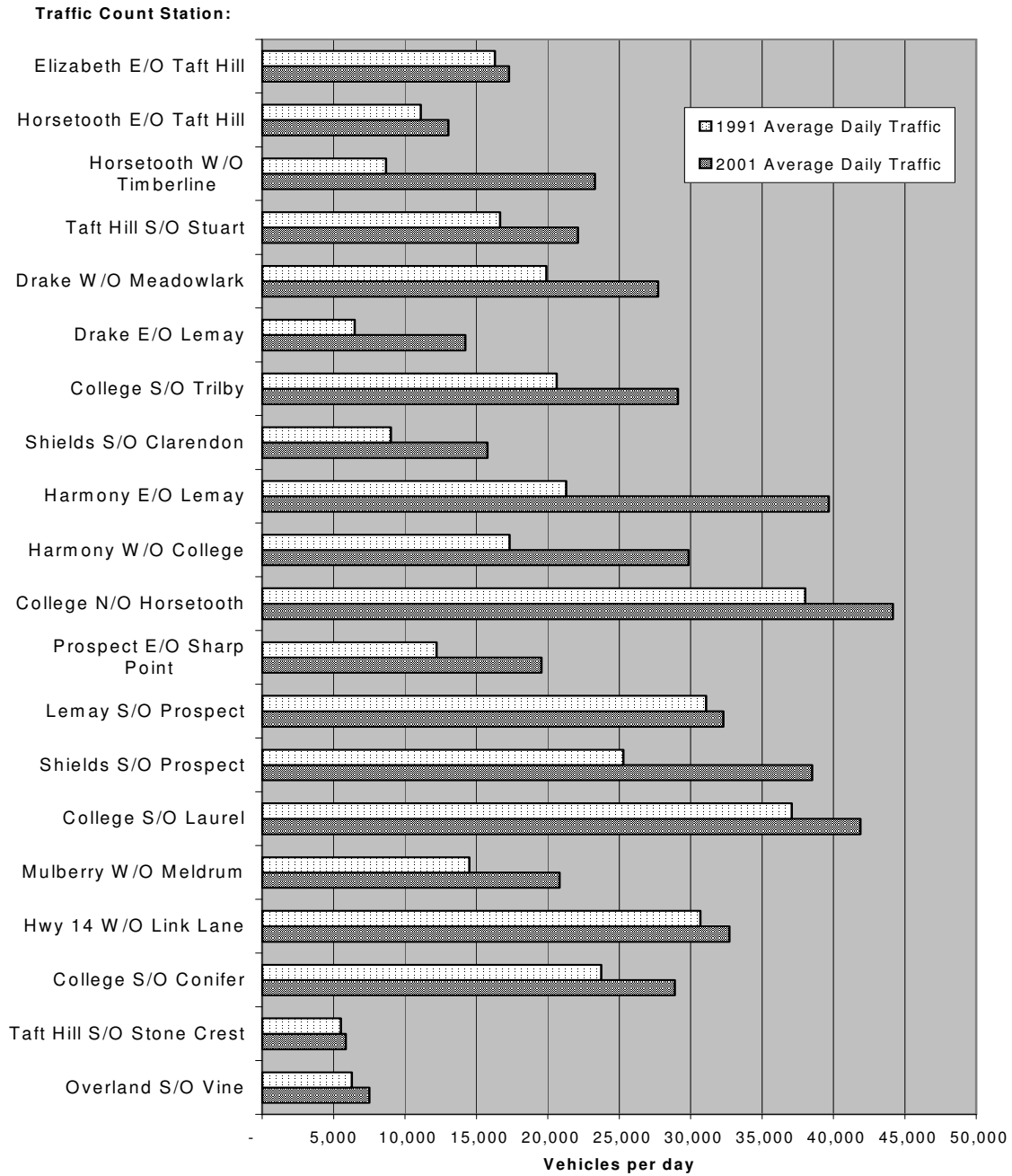
YEAR	SOURCE	VEHICLE MILES OF TRAVEL PER DAY
<b>1990</b>	2015 NFR RTP Model 1990 Base year	1,914,493
<b>1995</b>	2020 NFR RTP Model 1995 Base year	2,398,614
<b>1998</b>	2015 NFR RTP Model 1998 Base year	2,814,506

## Method 2 – Traffic Counts

Traffic counts constitute the only real data we have. But unless we were to count traffic on every segment of every street, traffic counts do not represent total VMT. Still, traffic counts provide a useful check on the VMT growth rate calculated from other methods.

Fort Collins arterial street traffic counts for 1991 and 2001 are shown in the following graph. Data table can be found in Attachment 3. A growth estimate is obtained by totaling the various counts and calculating a compound annual growth factor. This comes out to 3.1% annual growth 1991 through 2001 and 1.8% annual growth from 2000 to 2001.

### Fort Collins Traffic Counts, 1991-2001



The Highway Performance Management System (HPMS) maintained by the Federal Highway Administration provides another estimate of area-wide VMT which is based on local traffic counts. Estimates are reported for each urbanized area in the annual “Highway Statistics” report. However, the HPMS does not include travel on local/collector roadways and is based on only a few count locations on arterials. The traffic engineering profession generally believes that the HPMS under-estimates travel. The advantage of the HPMS is that it uses a consistent estimation methodology, which allows various urban areas to be compared. For our purposes, the change in the estimate over time matters more than the estimate itself – it provides another check on the VMT growth rate.

### **Highway Performance Management System**

YEAR	ESTIAMTED TOTAL DAILY VMT IN THE FORT COLLINS URBANIZED AREA
1994	1,887,000
1995	2,013,000
1996	2,012,000
1997	2,172,000
1998	2,262,000
1999	2,347,000

### **Method 3 – Fuel-Use Data**

USEPA published a methodology to estimate area-wide VMT based on fuel usage data. This is summarized in Attachment 2. The analysis boils down to a simple equation:  $VMT = [FUEL\ USE] \times [FUEL\ ECONOMY]$ . In other words,  $MILES = GALLONS \times [MILES\ PER\ GALLON]$ .

Data are available for the analysis. The tricky part, however, is zeroing in on the amount of fuel used in the Fort Collins area, because fuel statistics are reported only at the state level. Therefore we estimate Fort Collins share of statewide fuel use according to Fort Collins share of four other parameters relative to statewide totals:

- Population
- Vehicle registration
- Service station sales
- Total sales

There are a few drawbacks to this method. First, we are forced to assume that all fuel purchased here is used here, i.e., that fuel imported and exported inside vehicle fuel tanks cancels out. Second, the four local parameters used to disaggregate state fuel use give divergent results for the VMT compound growth rate, ranging from 4.3% to 13.2%. This analysis uses the average of all four, resulting in a 6.3% compound growth rate.

Among the advantages, this method estimates total area-wide VMT, which is the indicator we need, and it provides an estimate for each year. Thus the VMT estimate based on fuel use provides a check on both VMT and VMT growth rate.

## Conclusion, findings

The following graph shows the results for three methods: modeling, HPMS, and fuel-use. We can see that the model-based and fuel-based estimates are close. The HPMS-based estimate is lower, as expected, since it does not include collector/local streets.

### ***Best estimate of VMT growth rate***

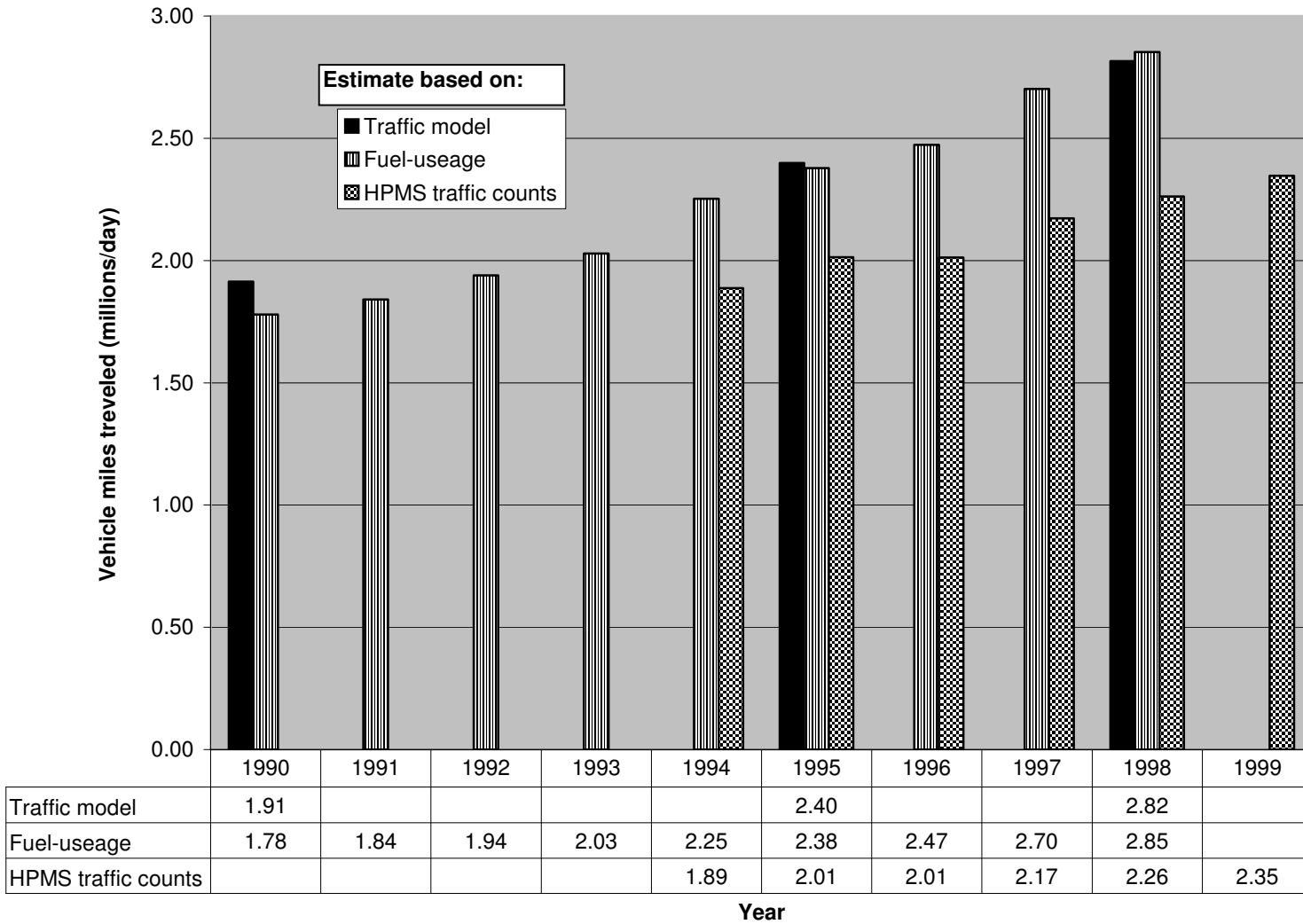
The following compound annual growth rates were calculated using all data from the summary graph:

ESTIMATION METHOD	COMPOUND ANNUAL VMT GROWTH RATE	COMMENTS
Model-based	4.9%	<ul style="list-style-type: none"> <li>Covers Urbanized Area</li> <li>Data for 1990, 1995, 1998 only</li> </ul>
Fuel-use-based	6.3%	<ul style="list-style-type: none"> <li>Covers City of Fort Collins</li> <li>Average of a range of estimates (4.3%-13.2%)</li> <li>Data for 1990-1998</li> </ul>
Traffic-count-based (HPMS)	4.4%	<ul style="list-style-type: none"> <li>Covers Urbanized Area</li> <li>Data for 1994-1999 only</li> </ul>
<b>Mean</b>	5.2%	
<b>Median</b>	4.9%	

The “best” estimate of VMT growth from 1990 to 1998 is probably around 5%. Since the model-based estimate is the presumed favorite, and since that method is close to both the mean and median of the estimates, **we select 4.9% as the best estimate of 1990-98 VMT growth within the Fort Collins Urbanized Area or Community Growth Area.**

It is worth noting that the Mobility Report Card reported that the compound annual VMT growth rate from 1995-1998 was significantly higher, at 7.3%. An examination of the Mobility Report Card data and modeling practice and assumptions show a manipulation of the base year (1995). The base year for the Mobility Report Card produced different VMT results than its NFR Regional Transportation Plan 1995 model counterpart. Based on an examination of the two models, staff determined the NFR Regional Transportation Plan 1995 model to be a more reasonable estimation of travel in that year. It should be noted that both models achieve a very similar estimate of VMT for the 1998 model year.

## Fort Collins VMT estimated three ways



It is possible that, over a three-year period, the growth could be higher or lower than our “best estimate” based on an eight-year period. We are confident, however, that 4.9% is a realistic estimate of VMT growth that could be sustained over the long term.

### ***Ratio of VMT growth to population growth***

The City Plan Monitoring Project reports every second year on a variety of indicators. One of these is the ratio of VMT growth rate to population growth rate — a “trigger indicator,” which tracks whether the ratio is greater than unity (VMT growing faster than population) or less than unity (VMT growing slower than population). The reporting period for the current biennial report is 1998-2000.

Unfortunately, we have no information specific to that time period. We assume, therefore, that our “best estimate” of 1990-1998 VMT growth holds for the 1998-2000 period as well. The state demographer data indicate the 1990-2000 population-growth rate for the City of Fort Collins is 2.9%. We assume that this growth rate applies as well to the Urbanized Area.

Using these estimates we calculate  $VMT \text{ growth} / POPULATION \text{ growth} = 4.9\% / 2.9\% = 1.7$ , or, expressed as a ratio, 1.7:1. **Therefore, VMT is growing faster than population and the City Plan indicator is “triggered.”**

Although we have made several assumptions in calculating this ratio, there can be little doubt that the indicator has been triggered. Even the lowest estimate of VMT growth discussed in this report (4.3%) is greater than the population growth rate. And although we would prefer to use the population growth rate for the Urbanized Area, our substitution of the City growth rate does not change the calculated ratio significantly. The ratio will be recalculated once census tract data become available that permit calculation of the Urbanized Area population growth rate.

### ***Best estimate of current VMT***

Because we have no estimates of VMT for year 2000, it will be necessary to use the previous years’ data to make a projection. The model-based estimates give us an equation to predict VMT for any year, assuming exponential (or compound) growth,  $VMT(\text{year}) = 1.8177 \exp(0.0479 * [\text{year} - 1989])$ . Using this equation we calculate the best estimate of current VMT as follows.

**Estimate based on 4.9% compound annual growth rate**

YEAR	TOTAL DAILY VMT IN THE FORT COLLINS COMMUNITY GROWTH AREA
1998	2,800,000
1999	2,930,000
2000	3,080,000
2001	3,230,000
2002	3,390,000
2003	3,550,000
2004	3,730,000
2005	3,910,000

**Regular updates of VMT and VMT growth**

Since traffic modeling has been selected as the best way to estimate both VMT and the VMT growth rate, it is important to perform traffic modeling and calibration on a regular basis. Every two years would meet most needs and specifically would suffice for the City Plan Monitoring Project. The resources needed in order to maintain a biennial, calibrated traffic model are being requested through the 2002-03 biennial budget process. It is worth noting that a biennial, calibrated traffic model would provide the City with a tool that would have usefulness far beyond the reporting of VMT and VMT growth.

In addition, the fuel-use-based and HPMS-based estimates will be updated annually in order to provide a crosscheck on the model-based estimates. Although the fuel-based and HPMS-based estimates are of secondary value, they have the advantage of being inexpensive and annual.

**Attachments:**

- 1. Traffic model memo**
- 2. Fuel-use methodology**
- 3. Traffic counts**

# ATTACHMENT 1

## MEMORANDUM

DATE: May 25, 2001  
TO: LUTRAQ Team  
THRU: Brian Woodruff  
FROM: John Daggett, Senior Transportation Planner  
RE: Modeled Vehicle Miles of Travel

The following analysis is based on examination of historical transportation demand forecasting model runs over the past decade. Staff examined four Regional Transportation Plan (RTP) models and the Mobility Report Card and Mason Models and selected the base year results for comparison. The Regional Transportation Plans were for the 2010, 2015, 2020, and 2025 planning horizons. Staff used the 1990, 1995, and 1998 base-year results.

This analysis is broken into two sets of estimates for VMT. The first set uses the trend line established by the RTP models starting with the 1990 base year. The second follows the trend established by the Mobility Report Card starting with the 1990 base year. The RTP 1990 base is common to both trend analysis approaches.

Percent change calculations are made using two methods: straight-line percentage increases and compounded percent change. The first assumes a linear relationship and implies a simple mathematical relationship between the highest and lowest value in the range of VMT numbers and probably overstates the rate of change.

The second method assumes there is a relationship between each annual increment of change. The compound method may more accurately describe the rate of change in the data being analyzed.

### The RTP Model Results

This approach specifically uses the forecasting models, validated to traffic counts, for model outputs for the base years (1990, 1995, and 1998) that were employed in the development of the 2015, 2020, and 2025 Regional Transportation Plans for the North Front Range Transportation & Air Quality Planning Council. The following table shows the results of comparative change in VMT and percentage growth over the eight-year period from 1990 to 1998. Percentage change is presented as both straight line and compounded.

### RTP Base Model Statistics

Year	Source	Vehicle Miles of Travel Per Day	Straight Line % Change in VMT (from Previous Base)	Straight Line % Change in VMT Annualized (from Previous Base)	Total Compounded % Change in VMT (from Previous Base)	Compounded % Change in VMT Annualized (from Previous Base)
1990	2015 NFR RTP Model - 1990 Base	1,914,493				
1995	2020 NFR RTP Model - 1995 Base	2,398,614	25.29%	5.06%	23.06%	4.61%
1998	2015 NFR RTP Model - 1998 Base	2,814,506	17.34%	5.78%	15.92%	5.47%
<b>Period 1990 - 1998</b>			47.01%	5.88%	39.44%	4.93%

#### The MRC Model Results

This approach specifically uses the forecasting models, validated to traffic counts, for model outputs for the base years (1990, 1995, and 1998) that were employed in the development of the 2015 Regional Transportation Plans and the Mobility Report Card project for the North Front Range Transportation & Air Quality Planning Council. The following table shows the results of comparative change in VMT and percentage growth over the eight-year period from 1990 to 1998. Percentage change is presented as both straight line and compounded.

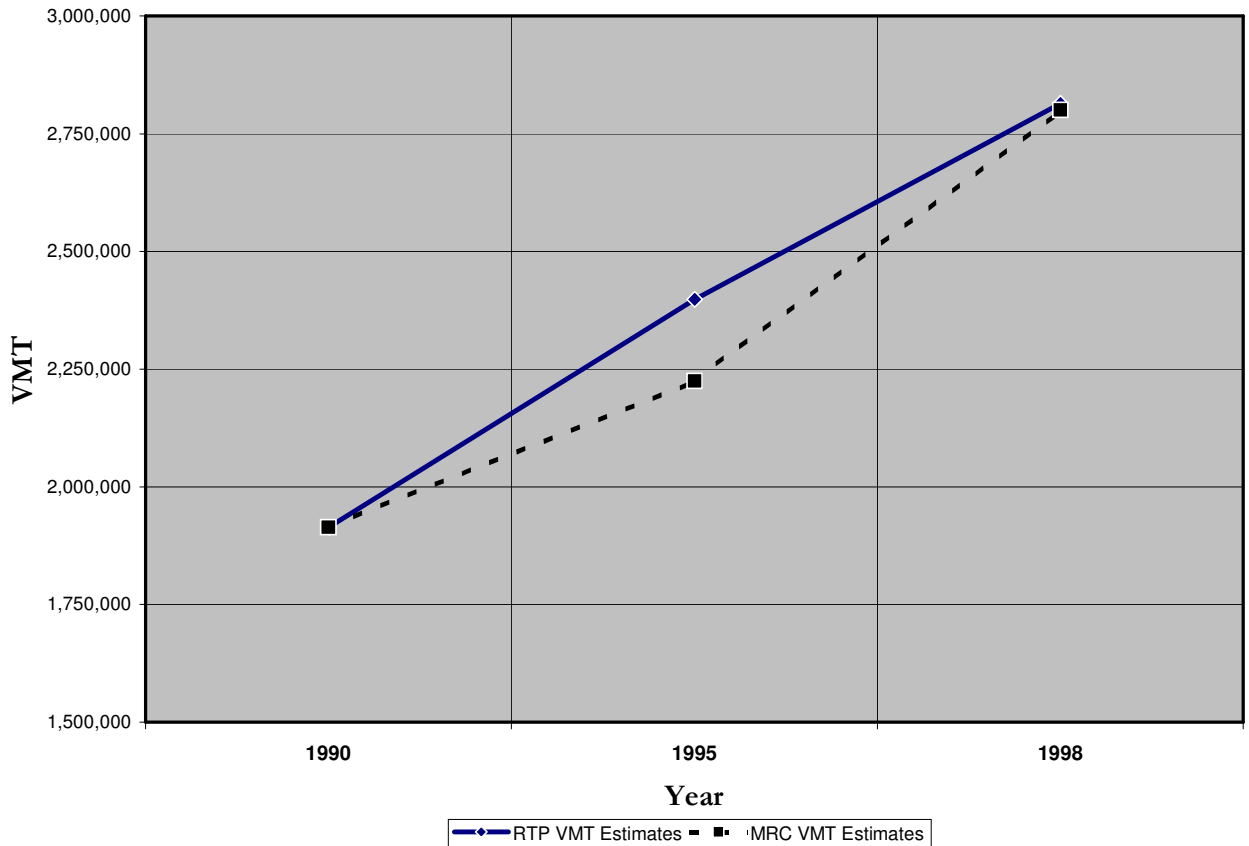
### MRC Base Model Statistics

Year	Source	Vehicle Miles of Travel Per Day	Total Straight Line % Change (from Previous Base)	Straight Line % Change Annualized (from Previous Base)	Total Compounded % Change (from Previous Base)	Compounded % Change Annualized (from Previous Base)
1990	2015 NFR RTP Model - 1990 Base	1,914,493				
1995	NFR MRC Model - 1995 Base	2,225,000	16.22%	3.24%	15.25%	3.05%
1998	NFR MRC Model - 1998 Base	2,801,000	25.89%	8.63%	23.94%	7.98%
<b>Period 1990 - 1998</b>			46.31%	5.79%	38.96%	4.87%

Conclusions

The following graph shows the difference in the two modeling outputs related to Fort Collins vehicle miles of travel.

### Fort Collins Vehicle Miles of Travel



Although there is a significant difference between the two model approaches as to when the VMT change occurred during the eight-year period from 1990 to 1998, the extent of the change over the entire period using either method gives similar results. The RTP approach yields a percentage change range of 47.01% (straight line) - 39.44% (compounded) for the entire period compared with the MRC approach results of 46.31% (straight line) - 38.96% (compounded).

Both analyses produce either straight line or compounded percent change for the entire period (1990-1998) well beyond population growth. The RTP method produces annualized straight line and compounded percentage change at 5.88% and 4.93% respectively. The MRC method produces annualized straight line and compounded percentage change at 5.79% and 4.87% respectively.

cc: Gary Diede, Transportation Operations & Projects Director  
Randy Hensley, Transportation Planning & Parking Manager

*Excerpt from*  
**ESTIMATION OF MOBILE SOURCE FUEL  
CONSUMPTION AND AREA VMT  
(Source: USEPA, 1996)**

**OVERVIEW OF METHODOLOGY**

Emissions associated with on-road motor vehicle use are an important element of any emission inventory. The USEPA provides a mobile source emission factor model (MOBILE) that estimates vehicle emission factors. These emission factors are combined with locale-specific estimates of vehicle miles traveled (VMT) to estimate mobile source emissions. VMT estimates are available from state departments of transportation (DOT) or county planning agencies, such as metropolitan transportation planning organizations (MPO). While readily available at the resolution needed for air quality planning purposes (e.g., county or even sub-county levels), these VMT estimates are usually compiled for transportation network planning purposes, not for air quality planning. The adequacy of these estimates for air quality planning purposes can vary depending upon the area and the VMT estimation methods used.

This subsection presents a method to independently derive VMT for comparison with transportation planners' estimates of VMT. Specifically, this section presents a means to estimate VMT from fuel consumption and fleet fuel economy. Locale-specific or national average data may be used, depending upon availability. If the results of this fuels-based method differ substantially from transportation planners' estimates, further investigation may be warranted.

In order to allow a valid comparison of results, the fuels-based method must be based upon data that are independent of transportation planners' estimates of VMT. Tax revenue data and demographic statistics are used to disaggregate statewide figures of on-road fuel consumption provided by the Federal Highway Administration (FHWA). On-road fuel consumption is also corrected for refueling losses. Locally determined fleet fuel economy is suggested for use, although national average fuel economy may be used if no other data are available.

**A. OVERVIEW OF CALCULATION PROCEDURES**

The basis of this methodology is a five-step procedure to estimate VMT. Before proceeding, the following data must be obtained:

- Statewide gasoline and special fuels consumption data which are published annually in *Highway Statistics* by the Federal Highway Administration.
- Information regarding the extent of Stage I and Stage II refueling control measures in the area of interest; these are available from state agencies or the EPA.
- Registration distributions and mileage accumulation rates should be used to determine local fuel economy if possible; otherwise, national averages contained in the MOBILE model can be used.
- Economic and population statistics which are maintained by state and federal agencies for the U.S., state, and counties of interest (see List of Contacts, Appendix A).

The five steps in the methodology, described in detail below, are as follows:

Step 1: Adjust statewide gasoline and special fuels distributions to account for off-road use.

Step 2: Geographically disaggregate fuel distribution from Step 1 and assign fuel volumes to the counties of interest according to each county's share of economic and population indicators.

Step 3: Adjust the fuel distributions obtained in Step 2 for refueling losses. The result represents the counties' on-road fuel consumption.

Step 4: Calculate diesel- and gasoline-powered fleet fuel economies. This is achieved by weighting on-road fuel economies according to vehicle stock (numbers of vehicles) and mileage accumulation rates. If possible, local data should be used. However, a method to use national averages extracted from MOBILE 5 is described for cases where no other data are available.

Step 5: Multiply on-road fuel consumption by fleet fuel economies to calculate VMT.

**ATTACHMENT 3**

**FORT COLLINS TRAFFIC COUNT DATA**

<b>Station #</b>	<b>Location</b>	<b>1991 Average Daily Traffic</b>	<b>2001 Average Daily Traffic</b>	<b>Diff. 91-01</b>	<b>% Change 91-01</b>
261	Overland S/O Vine	6,272	7,506	1,234	19.7%
255	Taft Hill S/O Stone Crest	5,512	5,864	352	6.4%
2085	College S/O Conifer	23,742	28,889	5,147	21.7%
2060	Hwy 14 W/O Link Lane	30,689	32,719	2,030	6.6%
2117	Mulberry W/O Meldrum	14,512	20,819	6,307	43.5%
2051	College S/O Laurel	37,083	41,896	4,813	13.0%
2033	Shields S/O Prospect	25,296	38,506	13,210	52.2%
2029	Lemay S/O Prospect	31,084	32,287	1,203	3.9%
2024	Prospect E/O Sharp Point	12,215	19,553	7,338	60.1%
277	College N/O Horsetooth	38,020	44,156	6,136	16.1%
2119	Harmony W/O College	17,314	29,858	12,544	72.5%
2114	Harmony E/O Lemay	21,291	39,677	18,386	86.4%
213	Shields S/O Clarendon	9,018	15,782	6,764	75.0%
200	College S/O Trilby	20,624	29,117	8,493	41.2%
2021	Drake E/O Lemay	6,472	14,224	7,752	119.8%
2019	Drake W/O Meadowlark	19,905	27,720	7,815	39.3%
2036	Taft Hill S/O Stuart	16,655	22,105	5,450	32.7%
2010	Horsetooth W/O Timberline	8,677	23,297	14,620	168.5%
2006	Horsetooth E/O Taft Hill	11,107	13,040	1,933	17.4%
2044	Elizabeth E/O Taft Hill	16,305	17,284	979	6.0%
	<b>Grand Total</b>	<b>371,793</b>	<b>504,299</b>	132,506	35.6%

Compounded Annual Growth Rate:

**3.10%**

<b>Station #</b>	<b>Location</b>	<b>2000 ADT</b>	<b>2001 ADT</b>	<b>Diff. 00-01</b>	<b>% Change 00-01</b>
261	Overland S/O Vine	7,493	7,506	13	0.2%
255	Taft Hill S/O Stone Crest	5,606	5,864	258	4.6%
2085	College S/O Conifer	28,754	28,889	135	0.5%
2060	Hwy 14 W/O Link Lane	33,409	32,719	(690)	-2.1%
2117	Mulberry W/O Meldrum	20,572	20,819	247	1.2%
2051	College S/O Laurel	41,719	41,896	177	0.4%
2033	Shields S/O Prospect	38,325	38,506	181	0.5%
2029	Lemay S/O Prospect	32,807	32,287	(520)	-1.6%
2024	Prospect E/O Sharp Point	18,782	19,553	771	4.1%
277	College N/O Horsetooth	48,194	44,156	(4,038)	-8.4%
2119	Harmony W/O College	30,672	29,858	(814)	-2.7%
2114	Harmony E/O Lemay	35,597	39,677	4,080	11.5%
213	Shields S/O Clarendon	15,515	15,782	267	1.7%
200	College S/O Trilby	28,007	29,117	1,110	4.0%
2021	Drake E/O Lemay	14,318	14,224	(94)	-0.7%
2019	Drake W/O Meadowlark	25,988	27,720	1,732	6.7%
2036	Taft Hill S/O Stuart	23,063	22,105	(958)	-4.2%
2010	Horsetooth W/O Timberline	20,542	23,297	2,755	13.4%
2006	Horsetooth E/O Taft Hill	12,493	13,040	547	4.4%
2044	Elizabeth E/O Taft Hill	16,684	17,284	600	3.6%
2132	Timberline N/O Prospect	10,596	11,619	1,023	9.7%
2131	CR-32 E/O Timberline	9,629	12,549	2,920	30.3%
	<b>Grand Total</b>	<b>518,765</b>	<b>528,467</b>	<b>9,431</b>	<b>1.8%</b>