PAY AS YOU DRIVE (PAYD) INSURANCE PILOT PROGRAM

PHASE 2 FINAL PROJECT REPORT

Prepared by:

Progressive County Mutual Insurance Company

- and -

The North Central Texas Council of Governments

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This study was a collaborative effort between Progressive County Mutual Insurance Company and the North Central Texas Council of Governments. This report was prepared in cooperation with the Texas Department of Transportation and the U.S. Department of Transportation, Federal Highway Administration, and Federal Transit Administration.

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PART 1: PROGRESSIVE COUNTY MUTUAL INSURANCE COMPANY ANALYSIS

Executive Summary

The North Central Texas Council of Governments (NCTCOG) is testing the concept of a “Pay As You Drive” (PAYD) insurance program in which the cost of auto insurance would vary based on mileage driven rather than being a fixed annual or semi-annual amount. The NCTCOG is attempting to understand whether there is a causal relationship between financial incentives and miles driven, and what effect this may have on vehicle emissions and air quality.

Progressive was selected as the auto insurance carrier partner for a PAYD insurance test in March 2006. Progressive enrolled 3,014 of its customers who agreed to participate in the test. Participants had the opportunity to earn an incentive by reducing the number of miles they drove during the test period. Mileage driven was recorded via a TripSensor® data-recording device that is plugged into the OBD port found beneath the steering column in each participating vehicle.

Key Findings:

- There was a high level of interest in the pilot program among Progressive customers, and the program was rated very highly by participants. 3,014 Texas drivers enrolled in the program.
- In addition to participation incentives, the average financial incentive for reducing mileage driven was $88 per period.
- The data indicate that the PAYD program decreased miles driven for participants by an average of 5%, or 560 miles per year.
- 37% of post-pilot survey respondents reported a reduction in mileage driven.
- The effect of the PAYD program is to reduce mileage during commute and mid-day hours. There was no effect on late night miles driven.
- There are both structural and lifestyle-related factors that hinder the use of carpooling and public transportation in the north central Texas area.
- Customers associate reduced mileage with a reduction in auto emissions.
- A lower auto insurance rate is among the top incentives cited by customers; these lower rates would make them consider carpooling or using public transportation.

About Progressive

Progressive has been in business since 1937 and ranks third in the nation for auto insurance based on premiums written and is the fourth largest auto insurer in Texas. Progressive is headquartered in Ohio, has a regional headquarters in Austin, and 35 claims offices located throughout Texas. In total, Progressive employees 1,900 people in Texas. Progressive seeks to be an innovative, growing and enduring business by providing our customers with great rates, superior online and in-person customer service, and innovative claims service. More information about Progressive can be found at *www.progressive.com.*

History of Progressive’s Usage-Based Insurance Programs

Progressive is committed to using technology in innovative ways to reduce the cost of car insurance for consumers and providing consumers with choices in how to shop for, buy and own an auto insurance policy.

This commitment has spurred our research and development of two usage-based automobile insurance programs.

Progressive introduced the first-ever usage-based automobile insurance program available to consumers in the US in 1998. Called Autograph™, the program was first test marketed in Houston and was made available to drivers throughout the state of Texas in 1999. Autograph was developed and patented by Progressive and involved the use of proprietary technology and global navigation positioning system (GPS) equipment retrofitted in customer vehicles. The Autograph test proved customers like usage-based auto insurance because it saves them money and gives them more control over their auto insurance costs. Autograph customers in Houston saved an average of 25% on their auto insurance when compared to what they were paying. Progressive ended the test in 2001.

In August 2004, Progressive introduced its second usage-based insurance program, called TripSense®, in Minnesota. The states of Michigan and Oregon have been included in the pilot program subsequently. With TripSense, customers plug a data-recording device into the OBD port in their car. The device collects information about the vehicle's use, including how many miles, the speed and time of day when the vehicle is driven. Customers earn a 5% discount for participating. Customers can earn up to 20% more in discounts based on how much and when the vehicle was driven.

Phase I of the TX PAYD Insurance Program

In December 2005, Progressive Insurance completed a statistical analysis to determine if there was a correlation between mileage driven and accident frequency. A positive correlation was found, which validated the hypothesis that insurance companies can provide financial incentives to customers who drive fewer miles because of associated reduction in claims costs.[1]

Description of the TX PAYD Insurance Program (Phase II)

Program Objectives

The NCTCOG is testing the concept of PAYD insurance that permits customers to purchase insurance on a per-mile basis rather than a fixed annual premium. The objectives of this study are:

- To determine if a PAYD option will induce drivers to reduce their mileage.
- To understand consumers' attitudes and experiences involving the PAYD program, and the program's effect on their driving behaviors.

Description of the Pilot

Progressive recruited 3,014 volunteers from eligible existing Progressive customers in nine Texas counties (Collin, Dallas, Denton, Ellis, Johnson, Kaufman, Parker, Rockwall, Tarrant). These volunteers agreed to share vehicle usage data in exchange for a research participation award of $50 or more for each eligible vehicle they registered for the research study. Existing Progressive customers with 1996 and newer model cars were eligible to participate. Not all vehicles in a household were required to participate in the program.

[1] Data was divided into 20 groupings based on annual mileage driven. Accident frequency relativities for these groupings ranged from 0.5 to 1.5, meaning that the highest annual mileage group has one and a half times as many claims as the average ($R2 > .82$). See the TX PAYD Insurance Program, Phase I report for further details.

Existing customers were sent invitations via direct mail solicitations beginning in April 2006. The year-long research study started in May 2006. It was limited to existing customers and the first 3,014 vehicles registered.

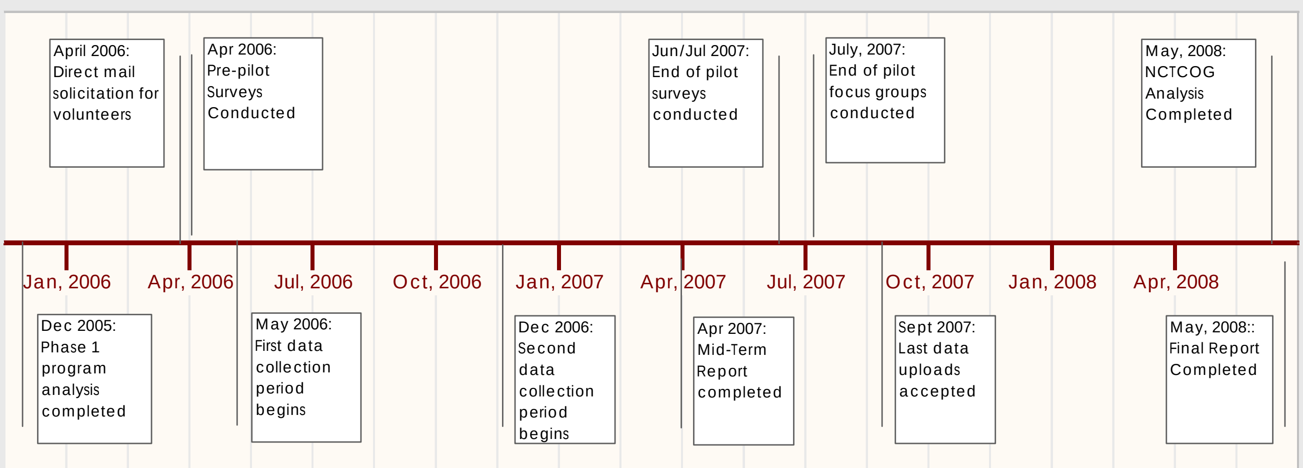
Research study volunteers were required to plug a TripSensor data-recording device into the OBD port found beneath the steering column in each participating vehicle for one year. Participants received a research participation reward of at least $50 per vehicle when they use the software provided to upload their driving data to Progressive after six months and again after 12 months. The amount each participant received may exceed $50 if they drove fewer miles than expected during the study. Participants were eligible to receive an additional $25 for every 5 percent fewer miles driven compared to the expected mileage each six-month term. They could earn up to $175 per term, and up to $350 in total for the study.

Baseline mileage was determined by odometer readings taken from recent emission inspections. If no readings were available, participants were not eligible for a mileage reduction bonus in the first six-month test period. In the second six-month period, if the TripSensor showed they drove less compared to the previous six months, they were then eligible for a reduced mileage bonus. Participation and receipt of research participation award was not contingent upon remaining a Progressive customer for the duration of the research study.

The six- and 12-month research participation rewards to eligible research study volunteers were paid in the form of American Express Travelers Cheques.

Progressive conducted statistical analysis on the data collected. Progressive also conducted two surveys, and four focus groups, to gain feedback from participants.

Figure 1: Texas PAYD Program Timeline



<u>Study Costs</u>

Federal funding in the amount of $1.5 million was available for phase two of the PAYD pilot program. In addition there was an incremental local match in the amount of $375,000 for a total project funding level of $1,875,000.

Progressive responded to the RFP with a Contract Pricing Proposal in the amount of $1,267,436. This included cost of the telematics device (32% of total), participation incentives for enrolled customers (28%), technical, IT and marketing labor costs (24%), customer recruiting expenses (9%), and consumer research expenses (7%). Final expenses were $804,845.50, or $465,590.50 less than anticipated in the original contract proposal. Progressive Insurance funded 21.7% of the total program costs.

Participant Interest

The level of customer interest in the PAYD pilot exceeded initial expectations. Progressive had planned to have two direct mailings to solicit customers to enroll in the pilot. However, all 3,000 available slots were filled within 10 days of the first mailing.

Statistical Results for the Texas PAYD Pilot

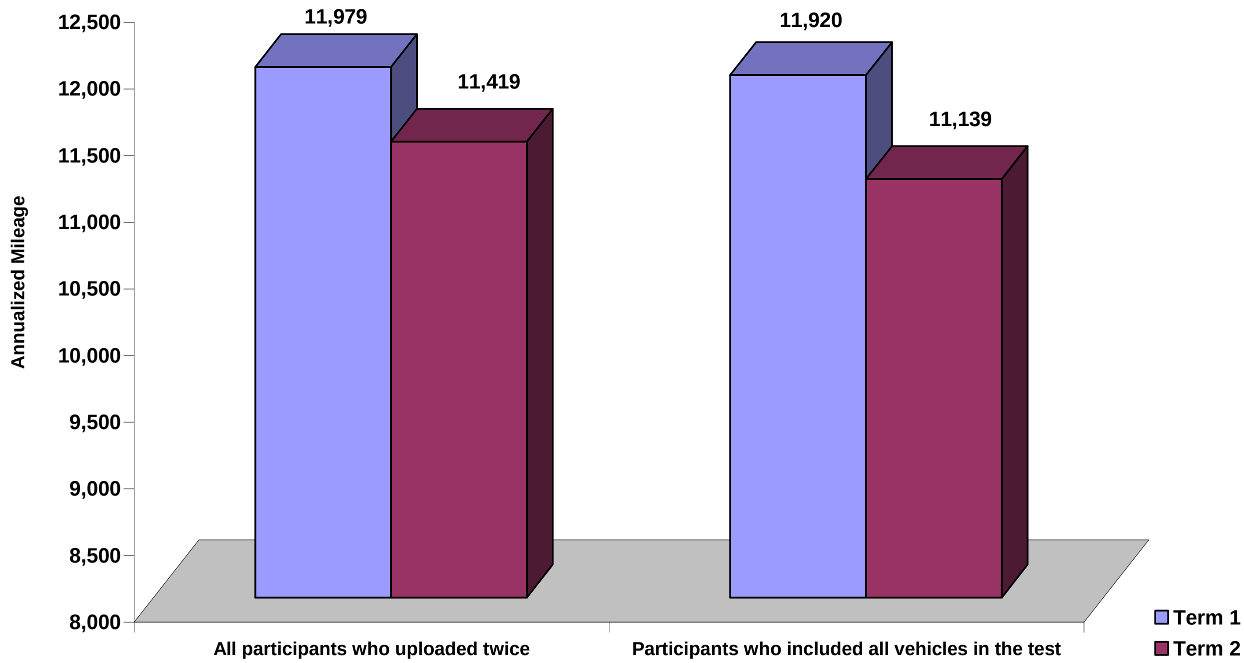
The PAYD pilot covered two six-month test periods. Participants were instructed to upload their data at the end of each period. A total of 2,981 data uploads were received. Of the 3,014 participants in the study, a total of 1,267 uploaded driving data to Progressive for both collection periods, and 447 participants uploaded data once[2]. In addition to the $50 participation incentive for uploading data to Progressive at the end of each period, participants who reduced their mileage during the study received an average mileage reduction incentive of $88.

Participants were divided into two groups based on whether baseline mileage data was available from the NCTCOG. Progressive received the baseline mileage data on only 93 of the 3,014 participants (3%), of which only 33 uploaded data to Progressive during both collection periods. This group had an ability to earn an incentive during both test periods by reducing their mileage driven relative to the mileage reading from the NCTCOG. For the majority of participants, the first collection period represented the first opportunity to measure mileage driven and establish a baseline mileage reading. These participants could then earn an incentive by reducing mileage driven during the second period. The statistical analyses focused on this larger group of participants.

The first statistical study looked at whether incentives encouraged participants to reduce mileage driven by comparing their baseline mileage to their subsequent term mileage. Progressive found that the average annual mileage decrease was 5% or 560 miles per year. This reduction is statistically significant at the 95% confidence level, meaning that there was a credible decrease in mileage driven due to the incentive (refer to Appendix: Exhibit 1).

[2] Based on survey results, 90% of participants installed their TripSensor device, 63% report downloading data to their computer at least once, and 52% report sending their data to Progressive at least once. See the end of pilot survey results for details.

Figure 2:
Summary of Average Mileage Driven
Term 1 vs. Term 2



Participant driving behavior was compared between periods to see how it changed in terms of mileage driven by time of day and time spent driving over 75 mph. When these participants were incented to drive less, they drove an average of 6%, or 390 fewer low-risk miles (mostly mid-day miles), and 3% or 160 fewer medium-risk miles (commute hour miles). Results were credible at the 95% confidence level. There was no significant reduction in high-risk miles (miles driven between 12:00 AM and 4:00 AM) (refer to Figure 3)[3].

Figure 3: Annualized Mileage Comparison

	Term 1	Term 2	% Reduction	t-Stat	Significant Reduction?
Low Risk Time Periods	6,886	6,493	5.7%	5.41	Yes
Commute Hour Time Periods	4,869	4,711	3.2%	3.45	Yes
High-Risk Time Periods	224	216	3.6%	0.76	No

In the mid-term report, the effect of incentives was investigated by comparing the driving behaviors of the group that could earn an incentive during the first period (those with previous odometer readings) to the group that could not. The conclusion was that the group with previous odometer readings drove less, with the caveat

[3] Detailed Results of the statistical analysis are shown in the appendix: exhibits 2, 3, and 4.

that some or all of the difference could be explained by sampling bias. Now that we have a second term of driving data in which both groups were financially incented, we were able to evaluate the effect of that potential bias on the results. We did this by comparing the difference in miles driven between the two groups during the second term, which should be due solely to differences in samples and random error, to the first term difference, which should also incorporate the effect of the incentive. This comparison revealed that those without odometer readings drove more in both periods than the group with odometer readings. While the difference in miles driven between groups decreased in the second term, an analysis of variance test concluded that this change was not statistically significant. This suggests that the difference in mileage driven between groups during the first term is due to sampling bias (refer to Appendix: exhibit 5).

There was also a discussion in the mid-term report concerning the possible effect of not requiring all vehicles in a household to participate in the test. The concern was that it would be possible for participants in multi-vehicle households, which signed up only one vehicle, to reduce mileage driven on that vehicle simply by using the other vehicle more. In this way, participants could earn an incentive without actually reducing mileage driven. To see what effect this had on the results, participants for whom we didn't have a baseline mileage reading from the NCTCOG were evaluated to see how many signed up all vehicles in their household, and how their mileage driven during the second test period compared to the mileage from the first period. We found 792 of the 1,234 participants who uploaded data after both test periods had signed up all vehicles, and that the average annual mile decrease for this group was 7%, or 780 miles per year. This was a statistically significant decrease in mileage driven at the 95% confidence level (refer to Appendix: exhibit 6).

Lastly, since the Dallas-Fort Worth area doesn't generally experience harsh winter weather, seasonal effects on driving behavior were not considered relevant. This conclusion was supported by data from the group of participants for whom we had baseline mileage data from the state. Since this group could earn an incentive during both collection periods, any difference in mileage driven between periods would be due to unexplained differences or random variation. 33 participants from this group uploaded data during both periods. They drove an average of 10,353 and 10,268 annualized miles during the first and second periods, respectively. This equates to a difference of only 0.8% (refer to Appendix: exhibit 7).

Pay As You Drive Insurance Participant Surveys and Focus Group Research

Progressive conducted two surveys and four focus groups as part of this study. The first survey was conducted prior to the beginning of the pilot, and included Progressive customers who reside in the nine-county area surrounding Dallas-Fort Worth. The purpose of the survey was to solicit customers' perceptions, attitudes and beliefs about mileage reduction and PAYD insurance. Near the end of the PAYD program, surveys and focus groups of program participants were conducted to solicit feedback on their experiences with the program.

PRE-PILOT SURVEY METHODOLOGY

Prior to the launching of the Pay As You Drive (PAYD) pilot, a pre-pilot survey of customers was conducted in order to gain knowledge of their receptivity to insurance pricing based on mileage driven, and their awareness of the link between mileage driven, auto emissions and clean air. An online survey of Progressive customers[4] residing in the nine-county area surrounding Dallas/Fort Worth, Texas was conducted from April 6, 2006 until April 30, 2006. A total of 1,183 Progressive customers responded to the survey.

The objectives of this study were:

[4] This survey included Progressive customers only, not the general market. Therefore, results are only generalizable in so far as Progressive's book of business is representative of the overall customer auto insurance market. Progressive is the third largest private passenger auto insurer in the country, and the fourth largest in Texas.

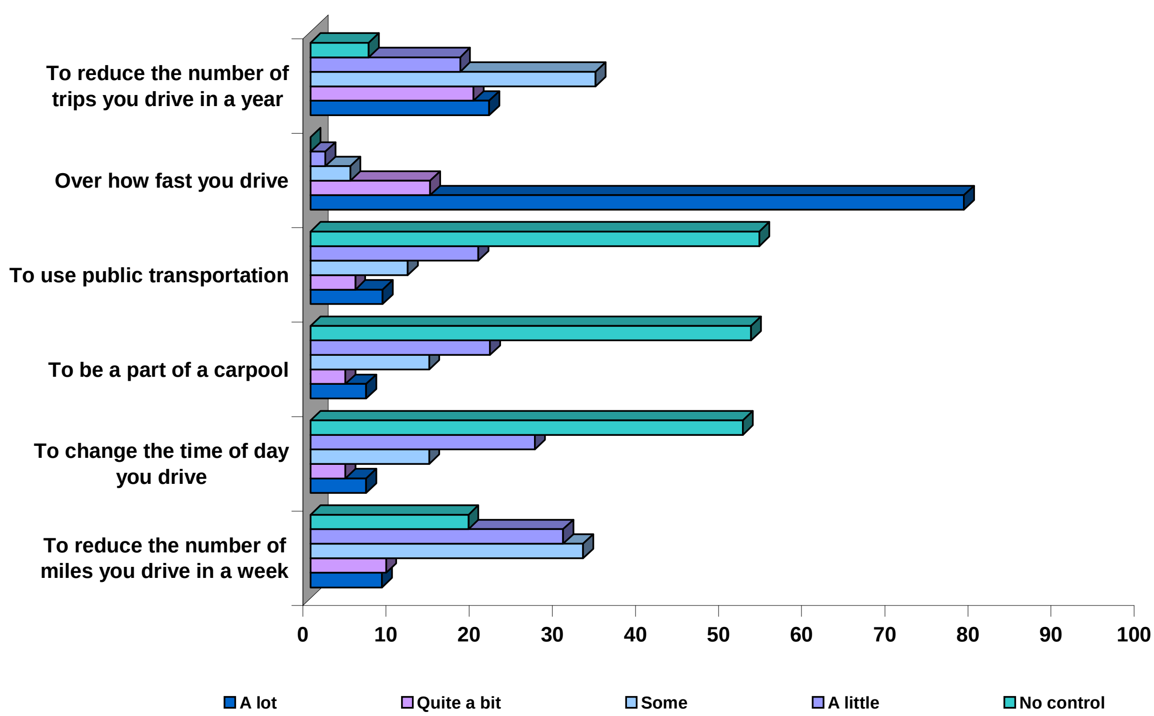
- To determine the interest in insurance pricing based on mileage driven
- To determine the interest in and ability to change one's driving behaviors in order to get a lower insurance premium
- To determine if insurance premium reduction will induce drivers to reduce mileage
- To determine if drivers associate reduced mileage with reduced auto emissions resulting in cleaner air

Pre-Pilot Survey Results

Lower auto insurance premiums ranked highly as an incentive to carpool or use public transportation. However, the necessity of driving (and therefore not changing one's driving behavior) often supersedes the insurance discounts that come from reducing miles driven.

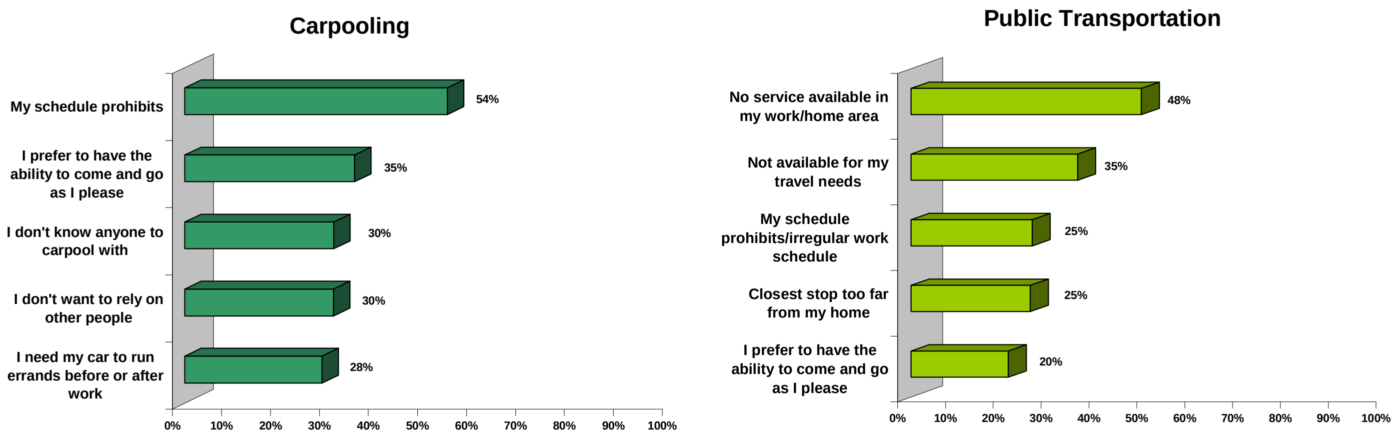
Drivers have little control over when and where they drive. Less than 20% say they have "a lot" or "quite a bit" of control to reduce the number of miles they drive in a week and less than 15% say they have "a lot" or "quite a bit" of control to change the time of day they drive. However, customers do feel very in control of how they drive; 93% of customers say they have "a lot" or "quite a bit" of control over how fast they drive (see figure 4).

Figure 4: Customer Perceived Control over Driving-Related Behaviors



Although in control of how they drive, childcare issues, work schedule, work location, and lack of available public transportation may prohibit drivers from participating in mileage reduction programs. 54% of respondents selected "my schedule prohibits" them from carpooling; the most frequent answer for public transportation is "no service available in my work/home area." "I need my car to take my children to and from daycare/school" was ranked as the top reason for not carpooling and the second ranked reason for not using public transportation (see figure 5).

Figure 5: Reasons Cited for not Carpooling or Using Public Transportation*



* MULTIPLE RESPONSE QUESTIONS

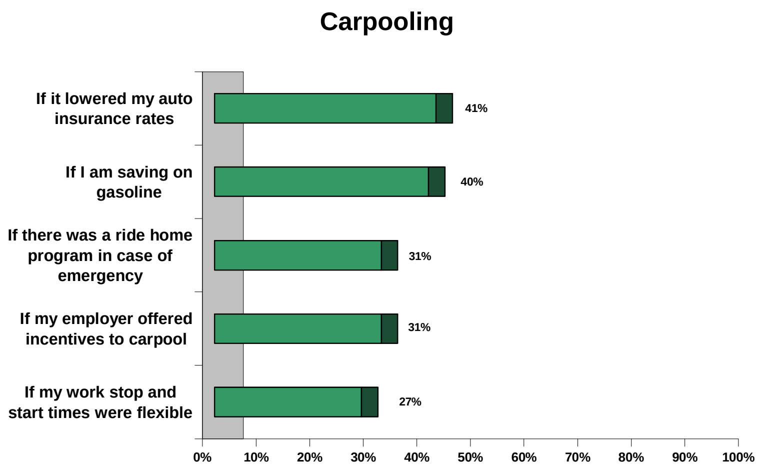
Lifestyle factors may also play a part in whether people are willing to carpool or use public transportation. "I prefer to have the ability to come and go as I please" ranked highly as a reason for not carpooling and using public transportation. In addition, "I don't want to rely on other people,", and "I need my car to run errands before or after work," were cited by 30% and 28% percent of participants, respectively, as reasons for not carpooling.

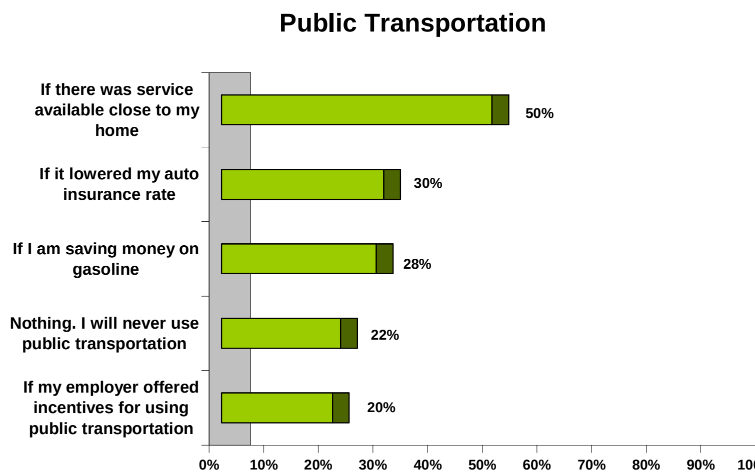
Despite this, drivers do associate reduced mileage with a reduction in auto emissions. Car emissions are listed as the most common contributor to air pollution and drivers rank clean air as the third most important factor for a city to have (refer to Appendix: exhibit 8).

When asked what would lead them to reduce miles driven, lower auto insurance rates is cited among the top incentives. Participants were asked to select from a list of incentives (which included lower auto insurance rates) that would make them consider carpooling and using public transportation, and then to rank those incentives in order of importance. A lower auto insurance rate is the most frequently mentioned incentive to carpool, and ranked second in importance among all incentives to carpool. Saving money on gasoline is ranked first among all incentives to carpool and is mentioned as an incentive to carpool by 40% of respondents.

The most frequently mentioned incentive to use public transportation is "if there was service available close to my home" (49%). Lower auto insurance was second, being mentioned as an incentive to use public transportation by 30% of respondents. The biggest obstacle to carpooling reported by customers is "my schedule prohibits" (54%). The biggest obstacle to using public transportation is "no service available in my work/home area" (48%) (See figure 6).

Figure 6: Most Frequently Mentioned Incentives to Carpool or Use Public Transportation *





* MULTIPLE RESPONSE QUESTIONS

Mileage reduction programs need to account for the barriers drivers face in reducing mileage, which involve daily responsibilities and access to public transportation, both of which are out of the customer's control. As one customer said during recruiting for the pilot, "Our society, and our cities and towns were developed in such a way that does not promote less driving but actually more commutes. I live in Dallas, Texas. I may have to drive anywhere from 30-45 minutes to get to work. But that is not of my own design, that is how society and city planners decided to design this world." Drivers recognize the connection between car emissions and air pollution and how they contribute to the problem. However, customers generally feel powerless to reduce their mileage.

END OF PILOT SURVEY AND FOCUS GROUP METHODOLOGY

Near the end of the Pay As You Drive (PAYD) pilot, a survey and four focus groups of PAYD participants were conducted in order to understand their experiences with the program and how the program influenced mileage driven. A telephone and online survey of Progressive customers participating in the PAYD program was conducted from June 11 through July 23, 2007.[5] A total sample of 811 Progressive customer participants was achieved. In addition, four focus groups were conducted July 23 to July 24, 2007 with a total of 43 participants. The participants were recruited to reflect the geographical area of the PAYD participants—one day near Dallas and one day near Fort Worth.

The objectives of these two research projects were:

[5] Telephone interviewing took place from June 11 through July 11, 2007. PAYD participants that were not able to be interviewed via phone were sent an email invitation and surveyed online from July 14 through July 23, 2007.

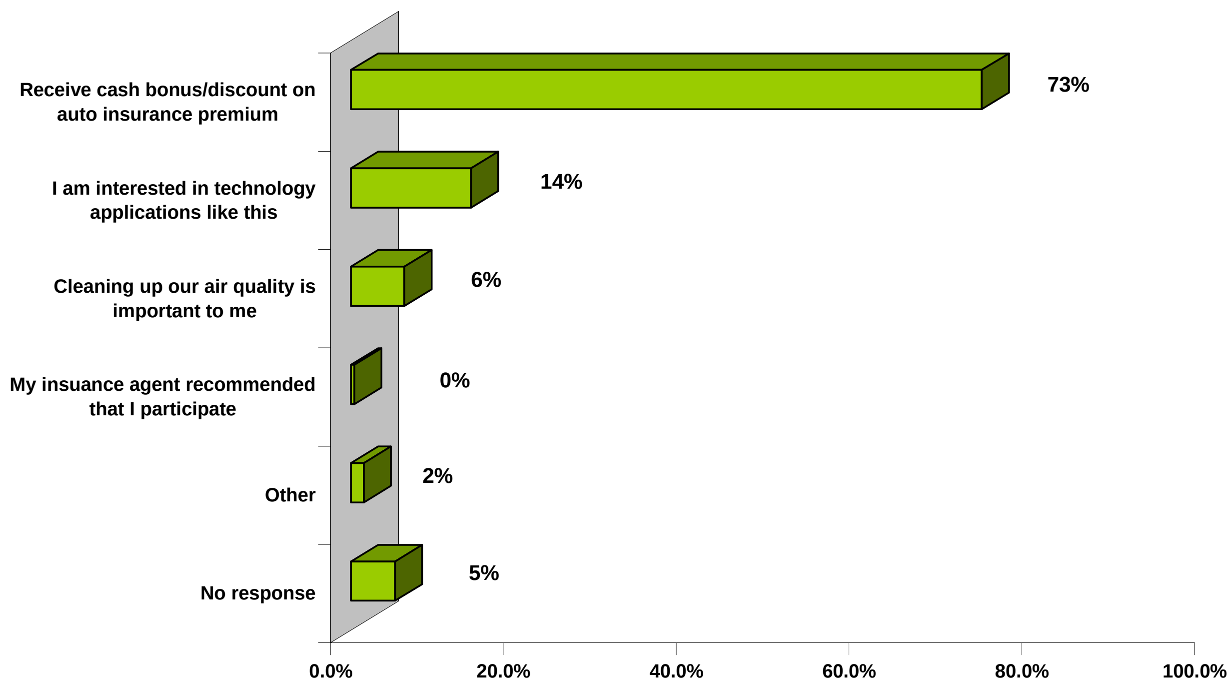
- To understand the effects the PAYD pilot program had on the driving behaviors of participants, especially mileage driven
- To determine if the incentive given to PAYD participants encouraged mileage reduction
- To understand what obstacles prevent mileage reduction
- To gain knowledge from participants about their experiences with the PAYD pilot program
- To gain knowledge about participants' attitudes and expectations toward a Pay As You Drive system

End of Pilot Survey and Focus Group Results

Overall, the Pay as You Drive program was rated very highly by participants. 87% of survey respondents were satisfied with the Pay As You Drive program, 81% of respondents would continue in the program if it were offered, and 89% of PAYD participants are likely to recommend Progressive to a friend or colleague.

The primary reason for participation in the PAYD program was the cash incentives. In response to a survey question asking why participants chose to participate, 73% said they wanted to receive a monetary incentive, and 14% said they're interested in technology applications (see figure 7).

Figure 7: Why Participate in PAYD



Surprisingly, only 6% of participants indicate their reason for participation is because "cleaning up our air quality is important to me," and only one focus group participant mentioned helping to protect the environment by driving less as a reason for participating. Despite this, it is clear from the focus group participants that cleaning up air pollution is important but they believe that they personally cannot have a large impact. Participants concluded that city planners should do more to create user-friendly public transportation.

Collecting the Data

At the end of each measurement period, program participants were instructed to unplug the device, plug it into their computer, view the data, and upload it to Progressive. A total of two thirds (67%) of participants included all the vehicles in their household in the study. 11% of participants report not being able to include all of their vehicles in the study because they had at least one 1995 or older vehicle.

As may be expected given the high level of interest in the PAYD program and willingness to participate, the majority of respondents (90%) installed the TripSensor in their vehicles. Of those who did not install the device, 31% said they did not understand how to do it or could not get it to work, 17% state they forgot, and 15% say they didn't have time. Unfortunately, 8% of respondents who did not install the device report they did not receive the TripSensor.

70% of survey respondents report downloading their data to their computer. Once downloaded, many focus group participants reported reviewing their driving data only prior to sending it to Progressive. However, individuals who were computer savvy and enthusiastic about the program and its technology applications report examining their driving reports several times during the length of the program. In addition, downloading the data affects program satisfaction; 87% of survey respondents who report being very satisfied with the program downloaded their driving data. Of those who did not download their driving data, 8% of respondents report they didn't understand how to download the data/could not get it to work, and another 6% report they did not know they could download the data.[6] Of those that downloaded the data to their computer, 83% sent the data to Progressive. Of those who didn't, the majority said they didn't understand how to do it, didn't know they were supposed to, or simply forgot to send the data.

Reporting and Safety

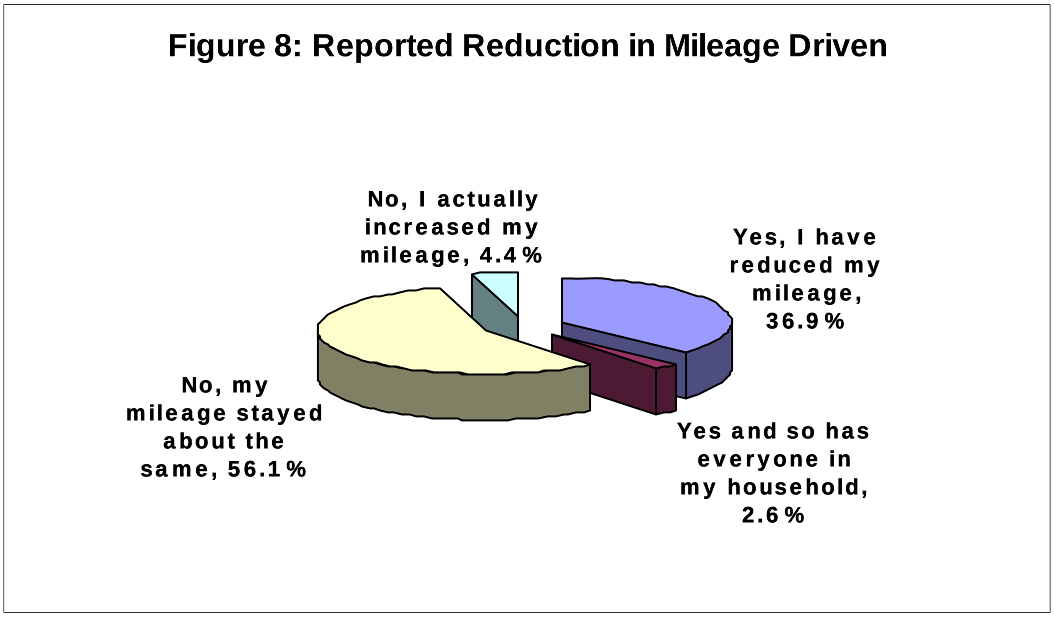
While some survey respondents had no reaction to their driving data or said it was what they were expecting, 36% saw driving behaviors of which they were not aware, and an additional 15% said that they found the driving data interesting. Focus group participants who looked at their driving data at any point during the pilot program said they were surprised about the information that was made available to them in addition to the mileage data. This information made them more conscious of their driving habits in general.

In addition, some participants said they would prefer their auto insurance premium to be based on safe driving habits, rather than on the number of miles they drive. This is not surprising given participants' feelings over their lack of control over where and when they drive. "To me number of miles isn't particularly making [me] a safe driver. If somebody rewarded me for being a gentler driver, the slower acceleration, the slower braking, the slower speeds overall, that would probably change my driving habits. The total number of miles, I'm stuck driving my 10 miles to work back and forth every day."

Mileage Reduction

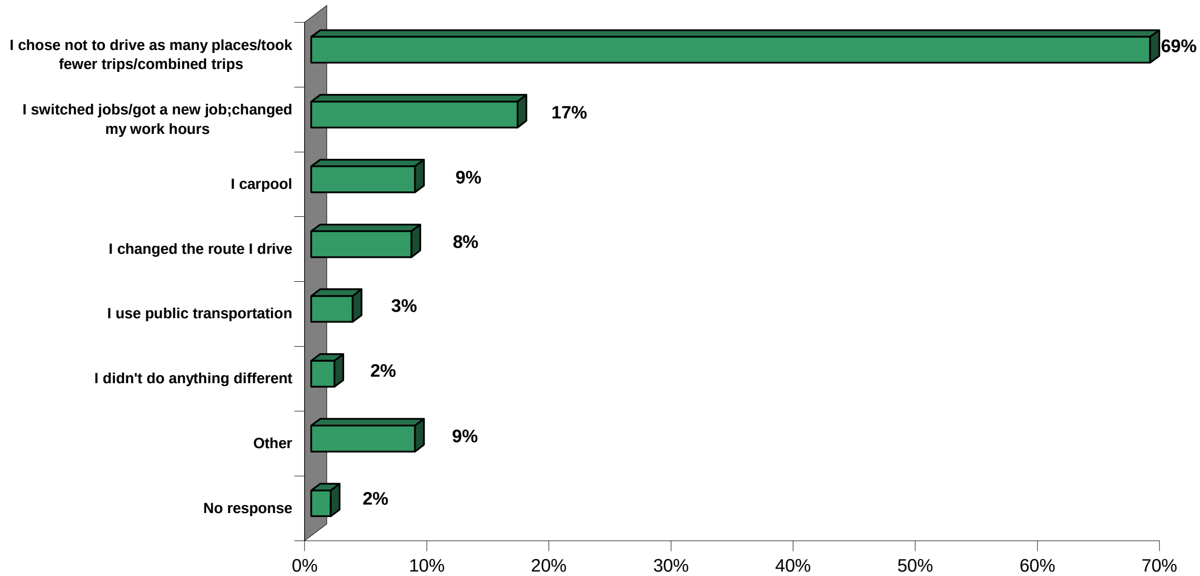
[6] Of the survey respondents who downloaded their driving data, 82% of respondents took the next step and sent their driving data to Progressive. The top reasons respondents state for not sending their driving data to Progressive are "I did not understand how to do it/I could not get it to work" (38%), I did not know I was supposed to" (20%), and "I forgot" (18%). Clearly, participants in the PAYD program who did not understand how the program worked were not able to participate completely or satisfactorily.

PAYD participants achieved decreases in mileage driven. 37% of survey participants report a reduction in their mileage as a result of being in the PAYD program (see figure 8).



61% of those who reduced their mileage saw a reduction of 50 miles per week or less. Mileage reduction was achieved by: taking fewer trips and combining trips (69%), switching jobs/changing work hours (17%), and carpooling (9%) (See figure 9). However, focus group participants said that switching jobs was not done purposefully to reduce mileage because of participation in the PAYD program, but instead was the result of life circumstances.

Figure 9: How Participants Reduced Mileage



Multiple response question

Most focus group participants feel they cannot reduce their mileage significantly because of the distance they drive to work. Constraints that prohibit substantial mileage reduction include: 1) the location of available and good-paying jobs, 2) lack of public transportation, and 3) extremely rare opportunities for carpooling. Participants reporting a significant reduction in mileage driven during the program did so because they moved closer to work or did not take any vacations or longer trips.

<u>Public Transportation and Carpooling</u>

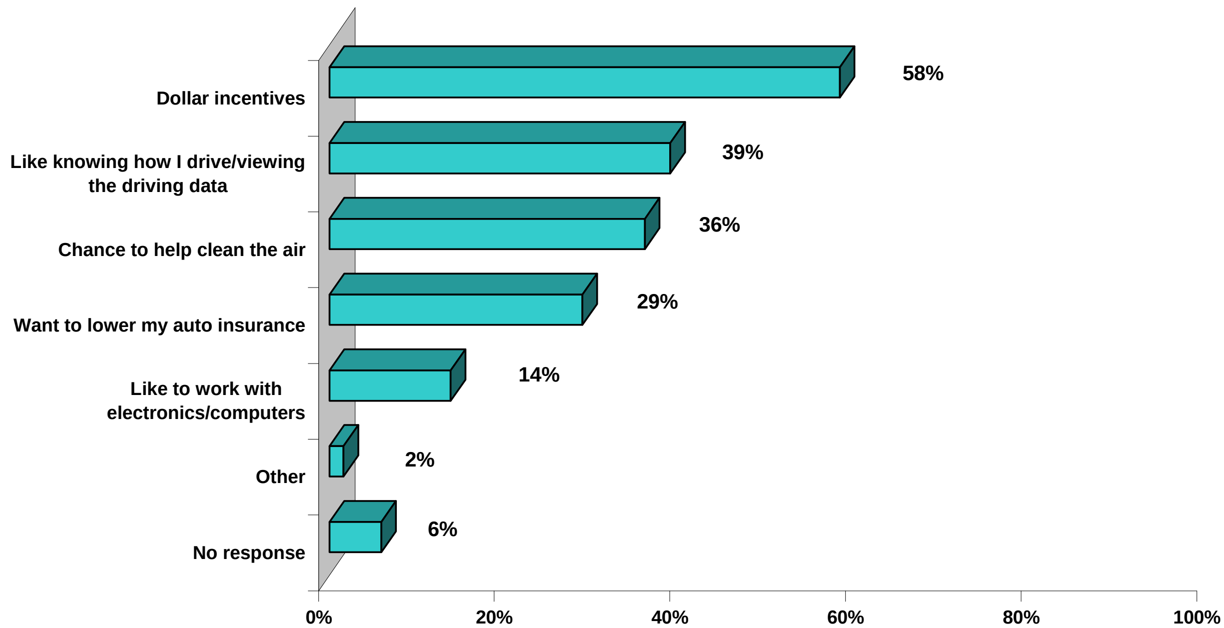
Participants believe public transportation can help clean up the region's air, reduce costly road maintenance, and cut back on car maintenance and parking expenses. However, focus group participants clearly state public transportation has too few options, access is problematic, and transit schedules do not provide realistic frequencies to get to jobs, entertainment, or shopping venues without unreasonable delays—if service is even available. Some participants noted that Arlington does not have any form of public transportation, and with the exception of the Trinity Railway Express, the various transit agencies are not connected and cannot provide seamless service.

Carpooling is also not seen as a viable option to assist participants in mileage reduction. The reasons for this are because participants 1) do not know how to locate persons who may be available to carpool, 2) have concerns for personal safety, 3) do not believe this is a reliable way to get to and from work, 4) have family and work obligations that are not flexible, and 5) perceive that park and ride lots have been vandalized. The lack of use of carpooling and public transportation is confirmed by the results of the survey; the majority of participants do not carpool (90%) or use public transportation (94%).

Thoughts on Future Pay As You Drive Programs from Survey and Focus Group Participants

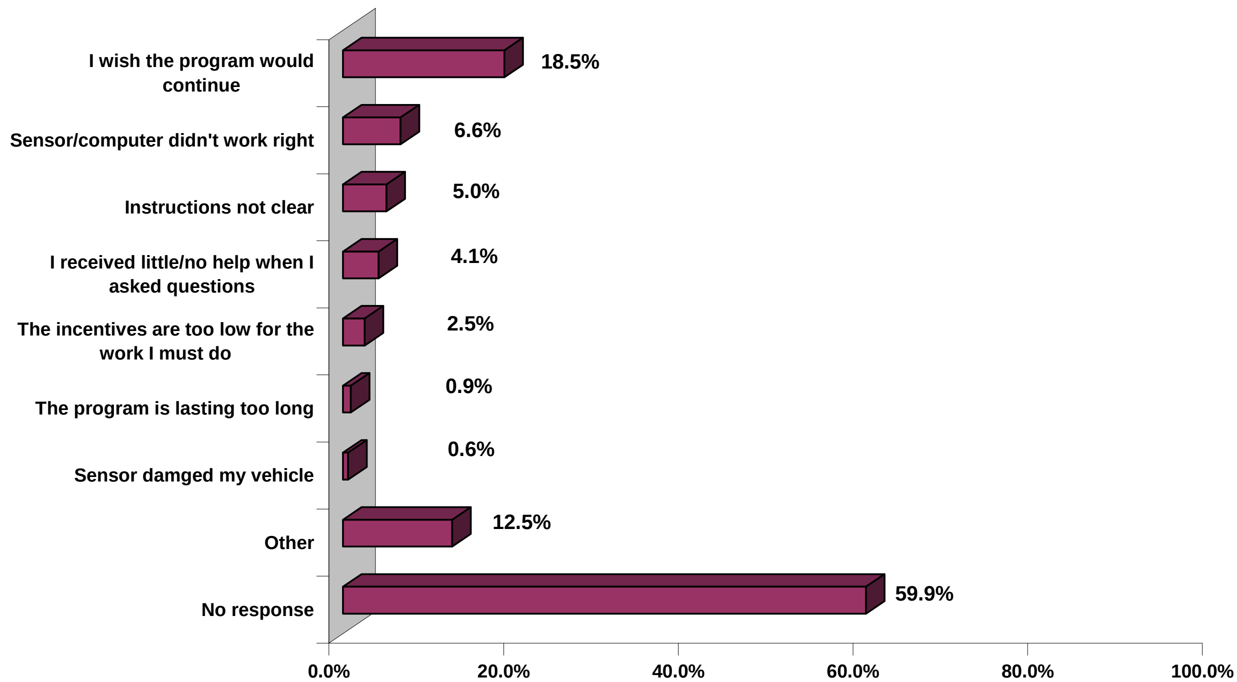
Enthusiasm is expressed for participating in a PAYD program in the future, especially in return for financial incentives. The four top likes of the PAYD program are 1) monetary incentives (58%), 2) knowing how I drive/viewing the driving data (39%), 3) chance to help clean the air (36%), and 4) want to lower my auto insurance (29%), (refer to figure 10)**.**

Figure 10: PAYD Program Likes



The program is seen as one that can be successful statewide and nationally by focus group participants. Problems with getting the TripSensor installed or working (7%), and problems with instructions (5%) are mentioned as the biggest dislikes and areas for improvement of the program (see figure 11).

Figure 11: PAYD Program Dislikes



Suggestions for Future Studies

This study showed that PAYD program participants will reduce mileage driven in return for a financial incentive. Further research opportunities exist to aid policymakers as they weigh options to reduce vehicle emissions and fuel consumption.

The effect of the incentive payment level on mileage reduction is an important consideration. While insurance companies should be willing to incent customers to reduce mileage driven by the amount of the associated reduction in loss costs, minus the cost of running the program, the tradeoff between increased incentives to consumers to drive less and expenditures on other programs to reduce vehicle emissions should be of interest to policy makers. Insurance companies should also be interested in this elasticity from a pricing perspective.

Additionally, the effectiveness of the program can be improved by looking for additional ways to reduce gasoline consumption and vehicle emissions within this framework. Further testing should be conducted to determine if PAYD insurance can be used to incent people to not only reduce mileage driven, but to change their driving habits in ways that will improve gasoline mileage. This may have particular appeal to consumers given that participants in the current study often expressed a lack of control over when and where they drive. There are many ways to reduce energy loss while driving and improve gasoline mileage such as: driving more slowly, taking the freeway, cruising to a stop rather than speeding up to it, that could be targeted within the framework of a PAYD insurance study.

Lastly, a device that would allow for automatic data uploads would dramatically improve the data retrieval rate from program participants and make for a more user-friendly process for participants to follow.

Appendix: Exhibits

Exhibit 1

Participants Without Beginning Odometer Readings

First Term Mileage Compared to Second Term Mileage (Annualized)

t-Test: Paired Two Sample for Means

	Uploaded Mileage(Term 1 Tripsense Device)	Uploaded Mileage(Term 2 Tripsense Device)
Annualized Average Mileage	11979	11419
Variance	39060327	37123151
# Observations	1234	1234
Pearson Correlation	0.79	
Hypothesized Mean Difference	0	
Degrees of Freedom	1233	
t Stat	5.24	
P(T<=t) one-tail	< .0001	
t Critical one-tail	1.65	

Exhibit 2

Participants Without Beginning Odometer Readings

Mileage Driven During Low Risk Time Periods (Annualized)

t-Test: Paired Two Sample for Means

	Uploaded Mileage(Term 1 Tripsense Device)	Uploaded Mileage(Term 2 Tripsense Device)
Annualized Average Mileage	6886	6493
Variance	14168834	13332407
# Observations	1234	1233
Pearson Correlation	0.76	
Hypothesized Mean Difference	0	
Degrees of Freedom	1233	
t Stat	5.41	
P(T<=t) one-tail	< .0001	
t Critical one-tail	1.65	

Exhibit 3 **Participants Without Beginning Odometer Readings** Commute Hour Mileage Comparison (Annualized) t-Test: Paired Two Sample for Means		
	Uploaded Mileage(Term 1 Tripsense Device)	Uploaded Mileage(Term 2 Tripsense Device)
Annualized Average Mileage	4869	4711
Variance	10778194	10906108
# Observations	1234	1234
Pearson Correlation	0.82	
Hypothesized Mean Difference	0	
Degrees of Freedom	1233	
t Stat	3.45	
P(T<=t) one-tail	0.0006	
t Critical one-tail	1.65	

Exhibit 4 **Participants Without Beginning Odometer Readings** Mileage Driven During High Risk Time Periods (Annualized) t-Test: Paired Two Sample for Means		
	Uploaded Mileage(Term 1 Tripsense Device)	Uploaded Mileage(Term 2 Tripsense Device)
Annualized Average Mileage	224	216
Variance	235480	303306
# Observations	1234	1234
Pearson Correlation	0.65	
Hypothesized Mean Difference	0	
Degrees of Freedom	1233	
t Stat	0.76	
P(T<=t) one-tail	0.4472	
t Critical one-tail	1.65	

Exhibit 5

Comparison of Miles Driven between Participants with and Participants without Odometer Readings

	Analysis of Variance	
Mean	**Odometer**	**No Odometer**
Term 1	10353	11985
Term 2	10268	11426
StdErr of Mean	**Odometer**	**No Odometer**
Term 1	1106	178
Term 2	1079	172
Term 1 Odometer < No Odometer		
t stat	0.30	
Pr(T<=t) one-tail	0.388	

Exhibit 6

Annualized Total Mileage Comparison
Participants Who Included All Vehicles in the Test
t-Test: Paired Two Sample for Means

	Uploaded Mileage(Term 1 Tripsense Device)	Uploaded Mileage(Term 2 Tripsense Device)
Annualized Average Mileage	11920	11139
Variance	38955909	35974425
# Observations	792	792
Pearson Correlation	0.78	
Hypothesized Mean Difference	0	
Degrees of Freedom	791	
t Stat	5.65	
P(T<=t) one-tail	< .0001	
t Critical one-tail	1.65	

Exhibit 7 **Participants with Beginning Odometer Readings** First Term Mileage Compared to Second Term Mileage (Annualized) t-Test: Paired Two Sample for Means		
	Uploaded Mileage(Term 1 Tripsense Device)	Uploaded Mileage(Term 2 Tripsense Device)
Annualized Average Mileage	10353	10268
Variance	24187379	29404377
# Observations	33	33
Pearson Correlation	0.60	
Hypothesized Mean Difference	0	
Degrees of Freedom	32	
t Stat	0.15	
P(T<=t) one-tail	0.44	
t Critical one-tail	1.67	

Exhibit 8: Auto emissions rank as most significant contributor to air pollution

5 most frequent answers mentioned as common air pollutants (multiple response)
Auto emissions 77.0%
Factory/industrial emissions 68.6%
Diesel fuel emissions 46.0%
Burning fossil fuels to make utilities such as electricity or natural gas 42.2%
Gasoline vapors 23.8%

Top 5 ranked common air pollutants (mean rankings)
Auto emissions
Factory/industrial emissions
Diesel fuel emissions
Burning fossil fuels to make utilities such as electricity or natural gas
Gasoline vapors

Base = 1183

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PART 2: NORTH CENTRAL TEXAS COUNCIL OF GOVERNMENTS ANALYSIS

Executive Summary

In this study, the North Central Texas Council of Governments (NCTCOG) analyzed the effect of Pay-As-You-Drive (PAYD) on reducing miles driven and the resulting air quality benefits associated with the change in driver behavior. A positive decline in emissions was realized with annual reductions of 0.47 tons of nitrogen oxides (NO_X), 433 tons of carbon dioxide (CO_2), and 0.02 tons of fine particulate matter ($PM_{2.5}$) based on the miles reduced by vehicles participating in this program. A much larger reduction is expected through a region-wide program, upwards of 157 tons of NO_X, 145,600 tons of CO_2, and 6.4 tons of $PM_{2.5}$ per year with a 10 percent penetration rate.

Regional participation was also analyzed for four land use types in relation to total miles traveled, total miles reduced, and percent miles reduced as a result of PAYD. The land use types studied included zoning, population density, proximity to sustainable development communities (SDC), and proximity to transit services. There was a direct correlation between total miles traveled and the last three land use parameters. That is, participants residing within densely populated areas, near SDCs, and/or near transit services, traveled fewer miles overall even though total miles reduced was roughly the same as participants not residing within those areas. Therefore, were PAYD to be offered on a total miles traveled basis, it would be of additional benefit to those residing in such areas due to driving fewer miles annually.

About NCTCOG

NCTCOG is a voluntary association of local governments serving a 16-county region of North Central Texas, centered around the two urban centers of Dallas and Fort Worth. Through designation by the Governor of the State of Texas and in accordance with federal law, NCTCOG serves as the Metropolitan Planning Organization (MPO) for the Dallas-Fort Worth Metropolitan Area. NCTCOG's Executive Board provides coordinated regional policy direction and fiduciary oversight to the MPO process while the Regional Transportation Council (RTC), comprised of local elected officials and representatives of the region's transportation providers, serves as the region's independent transportation policy body. As the MPO, NCTCOG and the RTC are responsible for planning and implementing transportation programs and projects aimed at reducing congestion, enhancing mobility, and improving air quality.

Nine counties in the NCTCOG service area have been classified by the Environmental Protection Agency as nonattainment for the criteria pollutant ozone, and the region has a federally-mandated deadline of June 2010 to come into compliance with this standard. Roughly three quarters of the emissions that contribute to the formation of ozone in this region are attributable to on-road and non-road mobile sources. Thus, numerous programs have been, and are currently being implemented to target these sources as part of a region-wide effort to improve air quality.

In 2004, the RTC approved $1.5 million to study the effect of mileage-based automobile insurance on reducing vehicle emissions. As part of this research effort, NCTCOG partnered with Progressive County Mutual Insurance Company (Progressive) through a competitive selection process. NCTCOG performed complementary analysis to Progressive's research in studying the effect of PAYD in the DFW region, which is discussed in further detail in the remainder of this report.

Regional Participation

Progressive annualized vehicle mileage data prior to submitting it to NCTCOG for analysis. Data included participant vehicle miles traveled (VMT) collected for the first and second six-month data collection periods, participant address and zip code, and the amount of time the *TripSense™* data collection device was plugged into the on-board diagnostic system. As Progressive previously touched upon, not all vehicles initially signed-up for program had acceptable data at the end of the data-gathering periods. A variety of factors contributed to this data being considered unacceptable including the device not being plugged in a minimum of 95 percent of the time, the participant not uploading data for both six-month data collection periods, and/or the participant moving out of the Dallas-Fort Worth (DFW) nine-county ozone nonattainment area.

In determining a reduction in annual VMT, mileage data from the second six-month period was subtracted from mileage data from the first six-month period. Participant zip codes were then cross referenced with a United States (U.S.) zip code data file to omit records that fell outside of the nine-county area. Records that had a VMT reduction greater than three standard deviations were also omitted to avoid skewing the results due to outliers.

The program was capped at the first 3,014 vehicles to be signed up. Many participants owned multiple vehicles resulting in fewer unique addresses than vehicles. There was a total of 2,040 households and 2,808 vehicles which equated to a 0.10 percent participation rate based on the total number of households in the nine-county area using 2005 population data extrapolated from the 2000 U.S. Census.[7,8] Of the participating vehicles, only 1,190 within the DFW nine-county area had complete data, and of these, only 1,173 had valid miles reduced data within three standard deviations. The percent of total households in each county is summarized in Figure 12 and a further breakout of vehicle categorization is provided in the appendix as Exhibit 9.

Figure 12: Regional Participation in Pilot Program

County	Participating Households (HH)	Total HH in County (2005)[7,8]	% of Total HH
Collin	300	234,109	0.13%
Dallas	821	813,635	0.10%
Denton	300	190,618	0.16%
Ellis	35	43,605	0.08%
Johnson	47	46,204	0.10%
Kaufman	19	27,756	0.07%
Parker	22	34,565	0.06%
Rockwall	24	14,530	0.17%
Tarrant	472	579,127	0.08%
SUM	**2040**	**1,984,149**	**0.10%**

Based on regional VMT counts ascertained from MOBILE6 Vehicle Emissions Modeling Software[9], average annual mileage for passenger cars and light-duty trucks in the nine-county ozone nonattainment area is approximately 15,225 miles per year. Participants in this study averaged 11,790 miles per year in the first period and 11,190 miles per year in the second period, which was a reduction of roughly five percent, or 600 miles, between the two periods. However, the average annual mileage

[7] NCTCOG. 2005 American Community Survey. www.nctcog.org/ris/census/searchcounty.asp
[8] City-Data. Rockwall County, Texas. www.city-data.com/county/Rockwall_County-TX.html.
[9] NCTCOG. MOBILE6 Vehicle Emissions Modeling Software

for the pilot program participants was 22 and 26 percent less than the regional average in the first and second period respectively.

Due to not having specific annual mileage data for each unique vehicle prior to the start of this program to compare with mileage accrual rates during this study, it cannot be definitively stated that participation in this pilot program caused a 22 to 26 percent reduction in mileage, but it does allude to PAYD having a positive effect on driver behavior and reducing annual miles traveled on average. According to a report on PAYD, recently published by the Brookings Institution[10], the effect of PAYD in the State of Texas may results in approximately a 7.4 percent reduction in VMT, which is a fair amount higher than that five percent reduction in VMT realized in this in analysis, thus making an argument that the results realized in this study may be a rather conservative estimate of the real world benefit of PAYD in Texas.

Emissions Reductions

Six vehicle pollutants were analyzed in this study including NO_X, CO_2, and $PM_{2.5}$ as well as volatile organic compounds (VOC), carbon monoxide (CO), and methane (CH_4). Emissions were calculated for each vehicle using 2007 MOBILE6 light-duty vehicle composite emission factors for NO_X, VOC, and CO and using the South Coast Air Quality Management District's EMFAC 2007[11] on-road emission factors for CO_2, CH_4, and $PM_{2.5}$. Emission factors are provided in the appendix as Exhibit 10. Analysis showed that a total reduction of 0.47 tons of NO_X, 0.55 tons of VOC, 5.9 tons of CO, 433 tons of CO_2, 0.04 tons of CH_4, and 0.02 tons of $PM_{2.5}$ resulted from the annualized miles reduced in this pilot program. Emission estimates were calculated for the 1,173 vehicles that had acceptable data. Emissions reduction data by county is provided in Figure 13.

Figure 13: Emissions Reductions Resulting from Pilot Program[9,11]

County	Resulting Annual Emissions Reductions (tons)					
	NO_X	VOC	CO	CO_2	CH_4	$PM_{2.5}$
Collin	0.006	0.006	0.073	5.80	0.001	0.0003
Dallas	0.168	0.199	2.109	149.53	0.014	0.0071
Denton	0.083	0.091	1.055	83.51	0.008	0.0040
Ellis	0.005	0.006	0.064	4.41	0.000	0.0002
Johnson	0.008	0.010	0.102	6.38	0.001	0.0003
Kaufman	0.007	0.009	0.094	6.30	0.001	0.0003
Parker	0.018	0.022	0.227	15.12	0.001	0.0007
Rockwall	-0.007	-0.008	-0.088	-6.55	-0.001	-0.0003
Tarrant	0.179	0.210	2.266	168.41	0.016	0.0080
SUM	**0.468**	**0.546**	**5.903**	**432.9**	**0.040**	**0.021**

NOTE: A negative symbol represents an increase in emissions.

Considering a scenario of widespread availability of mileage-based insurance in the near future, the real world emissions reductions would be substantially greater than those realized in this study due to the magnitude of participation and the achievable long term benefits. Todd Litman with the Victoria Transport Policy Institute, and one of the world's leading researchers on mileage-based insurance, claims that, "optional pay-as-you-drive is likely to attract 25-50 percent of policies during the first few years, with penetration increasing over time as it becomes more competitive compared with vehicle

[10] Bardoff, Jason E. and Pascal J. Noel. Pay-As-You-Drive Auto Insurance: A Simple Way to Reduce Driving-Related Harms and Increase Equity. Brookings Institution. July 2008.
[11] South Coast Air Quality Management District. EMFAC 2007 (v2.3). www.aqmd.gov/CEQA/handbook/onroad/onroad.html

year pricing".[12] Assuming future participants will exhibit similar behaviors to those in this particular pilot program, PAYD has the potential to significantly reduce emissions not only of ozone precursors, NO_X and VOC, but of other vehicle emissions including greenhouse gases, CO_2 and CH_4, and criteria pollutants, CO and $PM_{2.5}$. Additionally, with the drastic increase in fuel prices in recent months, and the slowdown in economic growth in the U.S., it is anticipated that greater interest in mileage-based insurance will come about as a means to help alleviate the ever rising costs of operating a vehicle.

Regional interest in PAYD was forecasted using 2007 vehicle registration data provided by the Texas Department of Transportation (TxDOT) and Todd Litman's projected rate of participation. At what may be considered a conservative penetration rate of 10 percent, which would equate to roughly 400,000 vehicles, the resulting emissions reductions would be presumably around 0.43 tons per day (tpd) of NO_X, 399 tpd of CO_2, and 0.02 tpd of $PM_{2.5}$. Figure 14 represents the theoretical emissions reductions that may be realized in DFW depending on the rate of participation in PAYD throughout the region.

Figure 14: Potential Emissions Reduced From A Region-Wide PAYD Program

Percent Participation of Registered Vehicles in Nine-County Region	Equivalent Number of Vehicles	Potential Emission Reductions (tpd)					
		NO_X	VOC	CO	CO_2	CH_4	$PM_{2.5}$
Pilot Program - 0.03%	1,173	0.0013	0.0015	0.016	1.19	0.0001	0.0001
10%	400,332	0.43	0.50	5.4	399	0.04	0.02
25%	1,000,831	1.08	1.26	13.6	998	0.09	0.05
50%	2,001,662	2.16	2.52	27.2	1995	0.19	0.09

Vehicles That Completed NCTCOG PAYD Pilot Program 1,173
2007 Light-Duty Vehicles Registered in Nine-County Region 4,003,323

Spatial Analysis

Spatial analysis related to four land use types was also studied. This included the relationships between reduced VMT and participant address location based upon: A) land use zoning, B) population density, C) proximity to sustainable developments, and D) proximity to transit service. Although many North Texans believe they do not have much control over how many miles they drive as shown in Progressive's pre-pilot survey results, NCTCOG hypothesized that the location of a participant's residence may have an effect on choices one has related to alternative modes of transportation, which can ultimately affect one's ability to reduce annual VMT. Data was analyzed using geographic information system (GIS) software and addresses were plotted using batch geocoding. The location of each address was cross referenced with spatial data files pertaining to the four above-mentioned categories. A summary of the analysis is discussed in further detail below with key findings summarized in Figure 15.

[12] Litman, Todd Alexander. Implementing Pay-As-You-Drive Vehicle Insurance: Policy Options. Victoria Transport Policy Institute. July 2002. www.ippr.org.uk/uploadedFiles/events/ToddLitman.pdf.

Figure 15: Reduced Mileage By Residence Location

	All Vehicles with Mileage Data	% of **All** Vehicles	Vehicles that **Reduced** Miles	% of Vehicles that **Reduced** Miles	% of **Total** Miles **Reduced**
A) Land Use Zoning					
Single-Family	827	70.5%	467	69.9%	69.33%
Multi-Family	140	12.0%	81	12.1%	10.95%
Hotel/Motel Zones	1	0.0%	0	0.0%	0.00%
Mobile Home	14	1.2%	6	0.9%	0.83%
Under Construction	33	2.8%	17	2.5%	2.54%
Institutional	11	0.9%	7	1.0%	1.34%
Retail/Office/Expanded Parking Zones	32	2.7%	24	3.6%	3.21%
Industrial	6	0.5%	3	0.4%	0.37%
Park	5	0.4%	4	0.6%	0.68%
Vacant	102	8.7%	58	8.7%	10.69%
Other	2	0.2%	1	0.1%	0.05%
TOTAL	1173	100%	668	100%	100%
B) Population Density					
Not dense areas (<1 person/acre)	121	10.3%	68	10.2%	11.08%
Slightly dense areas (1-5 persons/acre)	405	34.5%	224	33.5%	34.21%
Moderately dense areas (5-10 persons/acre)	502	42.8%	294	44.0%	43.24%
Very dense areas (>10 persons/acre)	145	12.4%	82	12.3%	11.47%
TOTAL	1173	100%	668	100%	100%
C) Sustainable Development Communities					
Within 0.5 miles of an SDC	11	0.9%	9	1.4%	0.9%
Within 1 mile of an SDC	53	4.5%	33	4.9%	3.7%
Within 2 miles of an SDC	138	11.8%	86	12.9%	9.9%
NOT within 2 miles of an SDC	1035	88.2%	582	87.1%	90.1%
TOTAL	1173	100%	668	100%	100%
D) Transit Services					
Within 0.5 miles of a transit center	33	2.8%	19	2.8%	2.39%
Within 1 mile of a transit center	101	8.6%	57	8.5%	7.47%
Within 2 miles of a transit center	263	22.4%	148	22.2%	20.19%
NOT within 2 miles of a transit center	910	77.6%	520	77.8%	79.81%
TOTAL	1173	100%	668	100%	100%

A) Land Use Zoning

Addresses for each of the participating vehicles were classified by zone type using GIS. Types of zones studied included single-family, multi-family, mobile home, vacant, under construction, and a handful of miscellaneous types. From this data, the resulting miles traveled and miles reduced by zone type was examined. In this study, 83 percent of addresses were located within residential zones. It is presumed that the remaining addresses were either places of employment, educational institutions, or new construction.

A t-Test: Two Samples Assuming Unequal Variances and a t-Test: Paired Two Sample for Means, referred to from this point forward as t-Tests, were performed using a 95 percent confidence level ($\alpha = 0.05$). Based upon this analysis, there did not appear to be a statistically significant correlation between reduced VMT in residential zones verses non-residential zones nor was there a significant difference between reduced VMT in single-family zones verses multi-family or mobile home zones. There was also no correlation between zone type and percent miles reduced likely due to large variability in this set of data. However, there did appear to be a slight correlation between fewer total miles traveled by participants residing in residential zones compared to those residing in non-residential zones.

The most current GIS zoning data available was from 2005, and addresses classified as being in vacant zones were considered to be non-residential units due to the uncertainly of these locations. It was hypothesized that a large number of these units may have been constructed after 2005 and the GIS zone type may not have accurately reflected the zoning category of these addresses in 2006-2007, which was when mileage data was collected.

A majority of the “vacant” units were located outside of the downtown and urban cores, likely the result of urban sprawl. A reason this study may have shown a higher VMT among this group of participants is that outside of the major metropolitan area, residents have longer trips, on average, due to being further away from major employment centers and other services. In addition, in newer areas, transit service has not yet been built to accommodate these residents, thus reducing the number of alternatives they have to driving.

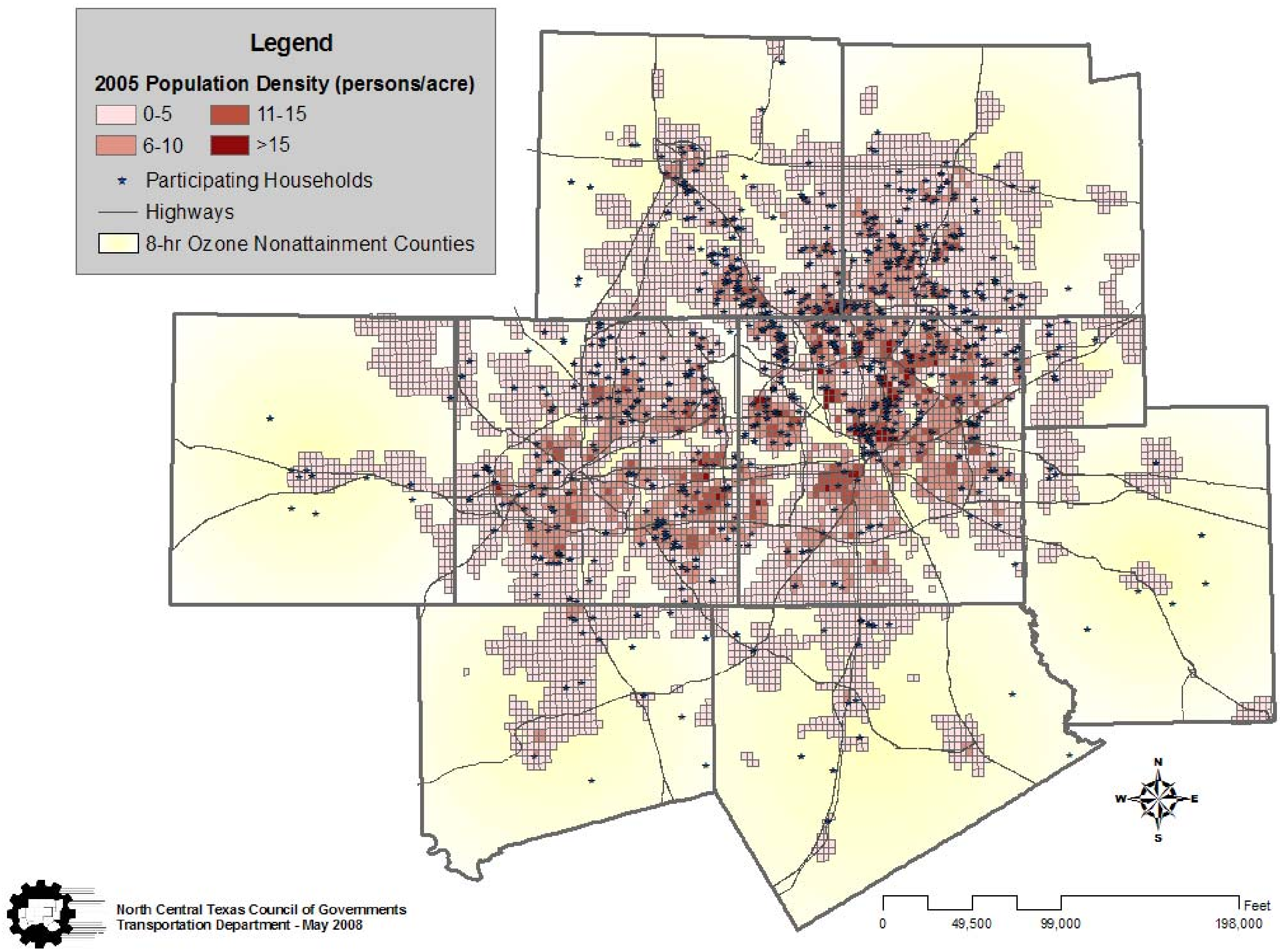
Within residential zones, driving behavior appears to be independent of zone type with participants residing in single-family zones driving approximately the same number of miles as those residing in multi-family zones. The lack of correlation between single-family and multi-family zones may be due in part to the fact that residents in North Central Texas are admittedly car-dependent and, due to the convenience of using passenger vehicles, most often travel via automobile rather than by other modes of transportation, either by choice or by lack of available alternatives. Data outputs are provided in the appendix as Exhibit 11 through Exhibit 14.

B) Population Density

Using 2005 population data extrapolated from the 2000 U.S. Census[7,8], NCTCOG analyzed data to determine whether there was a correlation between population density and reduced VMT. Density was analyzed in four segments: less than one person per acre; less than five persons per acre; less than 10 persons per acre; and greater than 10 persons per acre. The number of participating vehicles within each of these segments was 10.3 percent, 44.8 percent, 87.6 percent, and 12.4 percent respectively. The percent of vehicles within each of these segments that reduced VMT was around 56 percent across the board. Participants residing in areas of 10 persons per acre or greater, drove on average 24 percent fewer miles than participants residing in areas of one person per acre or less.

Based on t-Test analysis, there was a strong relationship between population density and total VMT. However, there did not appear to be a statistically significant correlation between reduced VMT and population density in any of the four segments nor did there appear to be a direct correlation with percent miles reduced. Analysis showed that participants residing in less densely populated areas (i.e. rural areas) had higher annual mileage than those residing in more densely populated areas (i.e. urban areas). This may be due, in part, to the notion that persons residing in higher-density areas are more apt to take advantage of mass transit service than those living in lower-density areas. Rural residents inherently have longer distances to drive to get to basic services located in more urbanized areas. A map showing regional population density is provided as Figure 16 and data outputs are provided in the appendix as Exhibit 15 through Exhibit 20.

Figure 16: Population Density



C) Sustainable Development

Sustainable development communities are preplanned neighborhoods, often in downtown areas near large employment centers, aimed at meeting human needs while preserving the natural environment and the resources required to sustain future growth and balancing access, finance, mobility, affordability, community cohesion, and environmental quality. There are currently 17 completed SDCs in the DFW nine-county area with several more being constructed over the next few years. In this study, 53 vehicles had addresses located inside, or within one mile of an SDC and, 138 were within two miles of an SDC. Of these two groups, 62 percent reported a decrease in miles traveled between the first and second period and, overall, participants residing near an SDC drove between 11 and 15 percent fewer miles than participants not residing near an SDC.

Based on t-Test analysis, there was a strong correlation between close proximity to an SDC and fewer total miles traveled, yet there was not a correlation between SDC proximity and total miles reduced or percent miles reduced. The mean annual VMT of participants residing within a two-mile radius of an SDC and outside of a two-mile radius was 10,343 and 12,116, respectively, during the first data collection period, and 9,700 and 11,523, respectively, during the second period.

These results are likely attributable to the notion that persons residing in or near an SDC often have better access to transit and may be more inclined to use alternative modes of transportation. In addition, SDCs are often walkable/bikeable which enables further mobility beyond the single occupant vehicle. Thus, an increased reduction in VMT due to close proximity to an SDC was most likely not observed in this study due to the baseline mileage data already taking into account traditionally lower annual mileage. It is important to note that although these participants reduced roughly the same number of miles as the rest of the participants, they inherently drive fewer miles which translate into lower emissions. Locations of SDCs relative to participant address location are provided in Figure 17 and data outputs are provided in the appendix as Exhibit 21 through Exhibit 24.

D) <u>Transit Service</u>

Historically, there has been great interest in mass transit in the DFW region and large investments have been made in order develop the requisite infrastructure. Transit not only enhances regional mobility, but also plays a significant role in improving air quality by eliminating passenger vehicle miles from the roadway system, thus reducing congestion, fuel consumption, and vehicle emissions. Transit services analyzed in this study included park-and-ride lots, light-rail stations, trolley stops along McKinney Avenue, Trinity Railway Express (TRE) stations (the TRE is the commuter rail line connecting the two downtowns of Dallas and Fort Worth), and other bus and multi-modal transit centers throughout the region. It was hypothesized that participants residing within close proximity to transit service would be more apt to take advantage of a mileage-based auto insurance program than other participants due to having a greater ability to choose alternative modes of transportation and would; thereby, show a greater reduction in annual VMT. However, such a conclusion could not be drawn from the data available in this study.

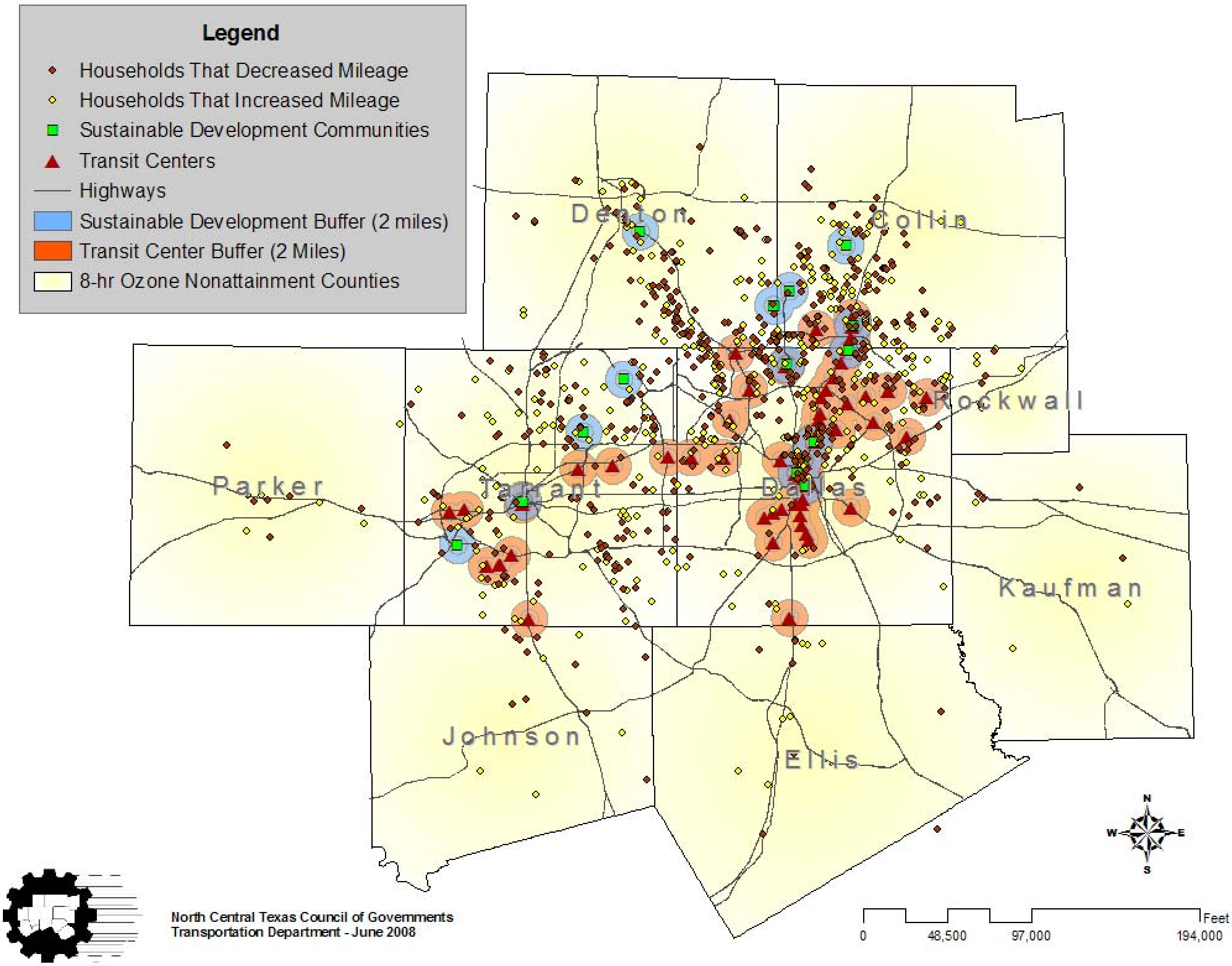
Analysis was performed based on a one-mile and a two-mile radius around transit service locations, with 101 vehicles and 263 vehicles located within each radius respectively. Based on t-Test analysis there was a strong correlation between close proximity to transit services and lower annual VMT. However, there did not appear to be a direct correlation between close proximity to transit services and reduced VMT nor was there a correlation related to percent miles reduced. The mean VMT of participants residing within two miles of transit services and outside of two miles was 10,394 and 12,354, respectively, during the first data collection period and 9,928 and 11,708, respectively, during the second period. Participants residing near a transit service drove between 15 and 21 percent fewer miles than participants not residing near transit.

The lack of correlation between proximity to transit service and a reduction in VMT is likely attributable to the notion that participants residing near transit service innately have lower annual mileage then those not residing near transit due to having mode choices related to transportation.

Therefore, although all participants reduced mileage at approximately the same rate, those residing near transit drove fewer total miles overall which equates to lower emissions.

These results are similar to those in the SDC analysis. This is likely due to the fact that SDCs often incorporate transit into the design, and many participants near these communities may have been utilizing transit services prior to this pilot program. Thus, a reduction in mileage may not be apparent in the data due to lower average annual mileage already being accounted for in the baseline data. Locations of transit services relative to participant address locations are also included in Figure 17. Data outputs are provided in the appendix as Exhibit 25 through Exhibit 28.

Figure 17: Sustainable Development and Transit Center Locations



Conclusion

During the data collection portion of this study, the U.S. economy was relatively strong and fuel prices were considerably lower than today. The current economic situation, however, is quite different. As a result, the reductions realized in this study may be a rather conservative estimate compared to the real world impacts of mileage-based insurance on reducing emissions. As a result of this study, there appears to be a positive relationship between participation in PAYD and participants reducing annual miles driven and a reduction in mileage has a direct correlation to a reduction in vehicle emissions. The overall reduction for the group was around five percent with 56 percent of the participants reducing mileage between the first and second data collection period. The number of miles reduced per participant appeared to be independent of residence location; however, participants living in more densely populated areas and near transit drove, on average, fewer annual miles than those residing in more sparsely populated areas. No correlation could be drawn about percent miles reduced due to large variability in this data set.

From this study, NCTCOG expects that were mileage-based insurance to be offered on a region-wide scale in DFW, it would have positive impacts on reducing vehicle emissions and improving air quality. People are looking for new ways to reduce the costs associated with operating a vehicle, and adjusting insurance premiums to a mileage-based system could help accomplish this through providing incentives to participants to reduce their annual miles and eliminate unnecessary trips. It is anticipated that the demand for mileage-based insurance will increase as the price of fuel continues to have a significant impact on the average household budget. NCTCOG strongly supports and encourages insurance carriers in offering PAYD insurance options to all customers in North Central Texas.

Appendix: Exhibits

Data Statistics

Exhibit 9: Vehicle Categorization

Data Group	Number
Total Vehicle Records	2922
With "Good" Data	2866
In 9-County Region	2808
With Complete Data	1190
Within 3 Standard Deviations	1173
That Reduced VMT	668
Total Individual Addresses	2103
With "Good" Data	2077
In 9-County Region	2040
With Complete Data	867
Within 3 Standard Deviations	853
That Reduced VMT	572

Exhibit 10: Vehicle Emission Factors

County	Emission Factors					
	NO_X (g/mi)*	VOC (g/mi)*	CO (g/mi)*	CO_2 (g/mi)**	CH_4 (g/mi)**	$PM_{2.5}$ (g/mi)**
Collin	0.498	0.541	6.322	502	0.047	0.024
Dallas	0.565	0.667	7.081	502	0.047	0.024
Denton	0.500	0.55	6.343	502	0.047	0.024
Ellis	0.569	0.706	7.304	502	0.047	0.024
Johnson	0.627	0.81	8.041	502	0.047	0.024
Kaufman	0.583	0.725	7.456	502	0.047	0.024
Parker	0.590	0.737	7.552	502	0.047	0.024
Rockwall	0.532	0.617	6.772	502	0.047	0.024
Tarrant	0.535	0.625	6.756	502	0.047	0.024

* MOBILE6 light-duty composite emission factors
** SQAQMD EMFAC 2007 (v2.3)

A) Land Use Zoning

Exhibit 11: Zoning - Non-Residential vs. Residential–Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Non-Residential	*Residential*	*TOTAL*
Mean Miles Reduced	855.1197917	548.8787	
Variance	13727235.12	11843861	
Observations	192	981	1173
Hypothesized Mean Difference	0		
df	260		
t Stat	1.059351701		
P(T<=t) one-tail	**0.145211391**		
t Critical one-tail	1.650735343		
P(T<=t) two-tail	**0.290422782**		
t Critical two-tail	1.969129946		

Exhibit 12: Zoning - Non-Residential vs. Residential–Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Non-Residential	Residential	TOTAL
Mean Total Miles Traveled (Period 1)	12868.083	11719.796	
Variance	43667220	35368609	
Observations	192	981	1173
Hypothesized Mean Difference	0		
df	255		
t Stat	-2.2370253		
P(T<=t) one-tail	**0.0130746**		
t Critical one-tail	1.6508511		
P(T<=t) two-tail	**0.0261493**		
t Critical two-tail	1.9693105		

Exhibit 13: Zoning: Residential - Single-family vs. Rest Residential–Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Single-family	*Mobile Home & Multi-Family*	TOTAL
Mean Miles Reduced	564.010	467.623	
Variance	12130500.94	10365909.94	
Observations	827	154	981
Hypothesized Mean Difference	0		
df	225		
t Stat	-0.33663828		
P(T<=t) one-tail	**0.36835168**		
t Critical one-tail	1.651654075		
P(T<=t) two-tail	**0.736703361**		
t Critical two-tail	1.970563339		

Exhibit 14: **Zoning: Residential - Single-family vs. Rest Residential–Total VMT**

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Single-Family	*Mobile Home & Multi-Family*	*TOTAL*
Mean Total Miles Traveled (Period 1)	11808.496	11243.468	
Variance	33883571	43346143	
Observations	827	154	981
Hypothesized Mean Difference	0		
df	200		
t Stat	0.9950516		
P(T<=t) one-tail	**0.1604568**		
t Critical one-tail	1.6525081		
P(T<=t) two-tail	**0.3209135**		
t Critical two-tail	1.9718962		

B) Population Density

Exhibit 15: Density: Less than 1.0 person per acre – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Less than 1 person/acre	1 person/acre or greater	TOTAL
Mean Miles Reduced	734.8678512	583.3783175	
Variance	12100729.94	12168760.36	
Observations	121	1052	1173
Hypothesized Mean Difference	0		
df	149		
t Stat	0.453526323		
P(T<=t) one-tail	**0.32541481**		
t Critical one-tail	1.655144534		
P(T<=t) two-tail	**0.650829621**		
t Critical two-tail	1.976013145		

Exhibit 16: Density: Less than 1.0 person per acre – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Less than 1 person/acre	1 person/acre or greater	TOTAL
Mean Total Miles Traveled (Period 1)	14339.73565	11628.02663	
Variance	49182648.07	34741683.37	
Observations	121	1052	1173
Hypothesized Mean Difference	0		
df	140		
t Stat	4.090414441		
P(T<=t) one-tail	**3.61627E-05**		
t Critical one-tail	1.655810511		
P(T<=t) two-tail	**7.23254E-05**		
t Critical two-tail	1.977053689		

Exhibit 17: Density: Less than 5.0 persons per acre – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Less than 5 persons/acre	5 persons/acre or greater	TOTAL
Mean Miles Reduced	536.4524905	649.8593354	
Variance	12742319.11	11688074.61	
Observations	526	647	1173
Hypothesized Mean Difference	0		
df	1102		
t Stat	-0.551468323		
P(T<=t) one-tail	**0.290712237**		
t Critical one-tail	1.646237528		
P(T<=t) two-tail	**0.581424473**		
t Critical two-tail	1.962118961		

Exhibit 18: Density: Less than 5.0 persons per acre – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Less than 5 persons/acre	Less than 5 persons/acre	TOTAL
Mean Total Miles Traveled (Period 1)	12905.68819	11096.4452	
Variance	44586078.71	29188873.09	
Observations	526	647	1173
Hypothesized Mean Difference	0		
df	1002		
t Stat	5.020282103		
P(T<=t) one-tail	**3.05205E-07**		
t Critical one-tail	1.646375771		
P(T<=t) two-tail	**6.10409E-07**		
t Critical two-tail	1.96233429		

Exhibit 19: Density: Less than 10.0 persons per acre – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Less than 10 persons/acre	10 persons/acre or greater	TOTAL
Mean Miles Reduced	596.0389105	620.0344828	
Variance	12415148.86	10371625.48	
Observations	1028	145	1173
Hypothesized Mean Difference	0		
df	196		
t Stat	-0.08298772		
P(T<=t) one-tail	**0.466972998**		
t Critical one-tail	1.65266506		
P(T<=t) two-tail	**0.933945996**		
t Critical two-tail	1.972141177		

Exhibit 20: Density: Less than 10.0 persons per acre – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	Less than 10 persons/acre	Less than 10 persons/acre	TOTAL
Mean Total Miles Traveled (Period 1)	12036.78214	10992.96546	
Variance	37751368.29	29890908.26	
Observations	1028	145	1173
Hypothesized Mean Difference	0		
df	199		
t Stat	2.118067008		
P(T<=t) one-tail	**0.017705199**		
t Critical one-tail	1.652546747		
P(T<=t) two-tail	**0.035410397**		
t Critical two-tail	1.971956498		

C) Sustainable Development Statistics

Exhibit 21: Sustainable Development: Vehicles within 1.0 Mile – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 1 mile of SDC	Not w/in 1 mile of SDC	TOTAL
Mean Miles Reduced	498.5660377	603.7580357	
Variance	6925769.481	12406832.12	
Observations	53	1120	1173
Hypothesized Mean Difference	0		
df	61		
t Stat	-0.27939424		
P(T<=t) one-tail	**0.390443716**		
t Critical one-tail	1.670219484		
P(T<=t) two-tail	**0.780887431**		
t Critical two-tail	1.999623567		

Exhibit 22: Sustainable Development: Vehicles within 1.0 Mile – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 1 mile of SDC	Not w/in 1 mile of SDC	TOTAL
Mean Total Miles Traveled (Period 1)	10658.30194	11966.87681	
Variance	26566693.58	37305879.37	
Observations	53	1120	1173
Hypothesized Mean Difference	0		
df	59		
t Stat	-1.78977084		
P(T<=t) one-tail	**0.03931145**		
t Critical one-tail	1.671093033		
P(T<=t) two-tail	**0.07862291**		
t Critical two-tail	2.000995361		

Exhibit 23: Sustainable Development: Vehicles within 2.0 Miles – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 2 miles of SDC	Not w/in 2 miles of SDC	TOTAL
Mean Miles Reduced	643.0797101	593.1285024	
Variance	7035031.636	12843174.05	
Observations	138	1035	1173
Hypothesized Mean Difference	0		
df	210		
t Stat	0.198401377		
P(T<=t) one-tail	**0.421461488**		
t Critical one-tail	1.652141982		
P(T<=t) two-tail	**0.842922977**		
t Critical two-tail	1.971324745		

Exhibit 24: Sustainable Development: Vehicles within 2.0 Miles – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 2 Miles of SDC	Not w/in 2 Miles of SDC	TOTAL
Mean Total Miles Traveled (Period 1)	10343.08692	12116.37298	
Variance	27303498.3	37804572.81	
Observations	138	1035	1173
Hypothesized Mean Difference	0		
df	191		
t Stat	-3.66286366		
P(T<=t) one-tail	**0.00016145**		
t Critical one-tail	1.652870548		
P(T<=t) two-tail	**0.00032291**		
t Critical two-tail	1.972461946		

<u>D) Transit Statistics</u>

Exhibit 25: Transit Services: Vehicles within 1.0 Mile – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 1 Mile of Transit	Not w/in 1 Mile of Transit	TOTAL
Mean Miles Reduced	476.2870297	610.5671735	
Variance	9835081.963	12379806.34	
Observations	101	1072	1173
Hypothesized Mean Difference	0		
df	125		
t Stat	-0.406862126		
P(T<=t) one-tail	**0.342402536**		
t Critical one-tail	8.42937E-08		
P(T<=t) two-tail	**0.684805073**		
t Critical two-tail	0.676457514		

Exhibit 26: Transit Services: Vehicles within 1.0 Mile – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 1 Mile of Transit	Not w/in 1 Mile of Transit	TOTAL
Mean Total Miles Traveled (Period 1)	9782.073125	12067.5	
Variance	21093713.3	3.8E+07	
Observations	82	1091	1173
Hypothesized Mean Difference	0		
df	104		
t Stat	-4.230802534		
P(T<=t) one-tail	**2.5136E-05**		
t Critical one-tail	1.659637437		
P(T<=t) two-tail	**5.02719E-05**		
t Critical two-tail	1.983037471		

Exhibit 27: Transit Services: Vehicles within 2.0 Miles – Miles Reduced

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 2 Miles of Transit	Not w/in 2 Miles of Transit	TOTAL
Mean Miles Reduced	466.3801901	637.3351758	
Variance	10634796.56	12598091.81	
Observations	263	910	1173
Hypothesized Mean Difference	0		
df	457		
t Stat	-0.733769521		
P(T<=t) one-tail	**0.231732743**		
t Critical one-tail	1.648194725		
P(T<=t) two-tail	**0.463465485**		
t Critical two-tail	1.965168411		

Exhibit 28: Transit Services: Vehicles within 2.0 Miles – Total VMT

t-Test: Two-Sample Assuming Unequal Variances - α = 0.05			
	W/in 2 Miles of Transit	Not w/in 2 Miles of Transit	TOTAL
Mean Total Miles Traveled (Period 1)	10394.35748	12345.1	
Variance	26432014.9	3.9E+07	
Observations	263	910	1173
Hypothesized Mean Difference	0		
df	507		
t Stat	-5.150918189		
P(T<=t) one-tail	**1.85878E-07**		
t Critical one-tail	1.647864622		
P(T<=t) two-tail	**3.71757E-07**		
t Critical two-tail	1.964653936		