CURRENT HOT LANE USAGE

Submitted as Part of the
HOUSTON HOT LANE NETWORK
Value Pricing Project 126XXIA005

Prepared for the
TEXAS DEPARTMENT OF TRANSPORTATION
Houston District

And the
FEDERAL HIGHWAY ADMINISTRATION

Prepared by

Mark Burris & Mandeep Pannu
TEXAS TRANSPORTATION INSTITUTE
College Station, Texas

September 2009

Executive Summary

This task (task number one) focused on collection of data related to the use of HOT lanes in Houston. Due to the reconstruction of Katy Freeway (I-10), and many of the monitoring systems on that freeway not functioning, most efforts were on the collection of data from the Northwest Freeway (US 290).

Vehicle speed data were obtained by two methods: WaveTronix sensors and Automatic Vehicle Identification (AVI) readers. The WaveTronix sensors collect data at a specific location and thus provide a spot speed. Based on these data it is clear that traffic speeds during the afternoon rush hour on the US 290 HOT lane often drop below 45 mph. The AVI readers collect information on when a vehicle passes a specific point on the HOT lane. The average speed of the vehicle between two of these points can be calculated using this information. These speeds corresponded well to the WaveTronix speed and provided confidence in the speeds collected.

Data on speeds in the general purpose lanes (GPLs) was also collected using AVI readers. In comparing the speeds on the GPLs and the HOT lanes it was clear the HOT lanes offered a much more reliable trip. Speeds on the US 290 HOT lane were generally between 56 mph and 66 mph, while the GPLs ranged from 12 mph to 64 mph. Katy Freeway speeds were similar. This lead to considerable travel time savings on the HOT lanes, exceeding 20 minutes in the afternoon on US 290.

Despite the significant travel time savings and reliability advantages of the HOT lanes there has been a steady decrease in QuickRide *use* since 2005. Part of this decrease was due to the Katy Freeway no longer being part of QuickRide – but that only happened in late 2008. Note that *enrollment* in QuickRide is still very high. What appears to be happening is that users with HCTRA tags are not informing METRO of their new tag numbers (due to the conversion to sticker tags this is most users), and many users with TxDOT tags have batteries that are dead.

Finally, there continues to be a significant number of violators (low occupancy vehicles) on the HOV lanes. This is particularly true during time periods when the lanes require HOV3+ occupancy – partially due to registered QuickRide patrons who are not paying their toll. During time period with HOV3+ requirements violation rates are approximately 30 to 40 percent, where other times violation rates are below 15 percent. The exact number is difficult to determine due to difficulties counting people in fast moving vehicles.

Table of Contents

Introduction

This task (task number one) focused on collection of data related to the use of HOT lanes in Houston. Due to the reconstruction of Katy Freeway (I-10), and many of the monitoring systems on that freeway not functioning, most efforts were on the collection of data from the Northwest Freeway (US 290). However, the use of QuickRide on Katy Freeway is documented and some initial results from the new Katy Managed Lanes are included.

To begin, a history of HOT lanes in Houston is necessary so that the reader can better understand how the HOT lane system has developed. When the Katy HOV lane opened in 1984, only transit buses and registered vanpools could use the lane. To make better use of road capacity, restrictions were relaxed in stages until any vehicle with two or more occupants (HOV2+) were allowed. The lane soon became congested during peak traffic periods due to the high number of carpool vehicle using the lane. This prompted Houston METRO, the transit agency responsible for the operation of the HOV lanes, along with TxDOT, to restrict usage to HOV3+ during the morning peak period (6:45 am to 8:15 am) in 1988. The time period changed to 6:45 am to 8:00 am in 1990 and has not changed since. Soon after, congestion during the afternoon peak period (5:00 pm to 6:00 pm) necessitated HOV3+ restrictions then as well. Most recently, the morning peak period (6:45 am to 8:00 am) on the Northwest Freeway (US290) also changed occupancy restrictions to HOV3+.

Not surprisingly, these occupancy restrictions (HOV3+) resulted in a considerable reduction in peak period traffic and available capacity in the HOV lanes. However, less onerous restrictions (HOV2+) had resulted in excess demand and congestion on the lanes. One potential solution was to allow HOV2s to use the lanes for a price during the peak periods. This would limit demand to an acceptable level, make more efficient use of the lane, and provide a revenue source to help pay for the program. Thus, Houston's QuickRide program was created.

QuickRide began in January 1998 on the Katy Freeway and then in November 2000 on the Northwest Freeway. To use the HOV lanes during periods normally restricted to vehicles with three or more occupants, vehicles with two occupants pay a $2 toll and a $2.5 monthly fee. This form of HOV lane is often referred to as a high-occupancy/toll (HOT) lane. As of May 2009, there were only 9 HOT lanes in existence (all in the United States). However, many cities are exploring the option of converting HOV lanes to HOT lanes (Value Pricing Homepage, 2009). The existing HOT lanes include:

1. I-15 near San Diego
2. SR-91X near Los Angeles
3. I-15 near Salt Lake City
4. I-394 near Minneapolis
5. I-25 near Denver
6. SR-167 near Seattle
7. I-95 near Miami

8. I-10 in Houston
9. US-290 in Houston

In addition to making more efficient use of roadway capacity, HOT lanes offer travelers the additional choice of paying for fast, reliable travel. Evidence from California and Houston HOT lanes indicates few drivers use the lanes on a frequent basis (Burris and Appiah, 2004; Sullivan, 2000; Supernak et al., 2001). Rather, the majority of drivers use the lane infrequently, possibly when they are particularly pressed for time or cannot risk the unreliable travel times offered by the free lanes. The remainder of this technical memorandum will examine data on the use of the HOT lanes in Houston.

Data Collection

The speed and volume data were collected for the US290 HOT lane using two methods (Table 1):

Table 1. Data Collection Details for US 290 HOT Lane

Data Collection Device	Time Interval	Data Recorded	Date of Data Analyzed
Wavetronix	Minute interval	Speed, Volume	August 2007 to December 2007
AVI	15 minutes	Speed	January 2007 to December 2007

Wavetronix Sensors:

Wavetronix sensor data were collected from Northwest Freeway (US 290) HOT lane for four months, starting August 1, 2007 until December 31, 2007. Vehicle data were aggregated in minute intervals. Collected data had various parameters including Sensor ID, Date, Lane, Road Number, Description, Speed, Volume and Occupancy. Data was collected at four locations shown in Figure 1 and Table 2.

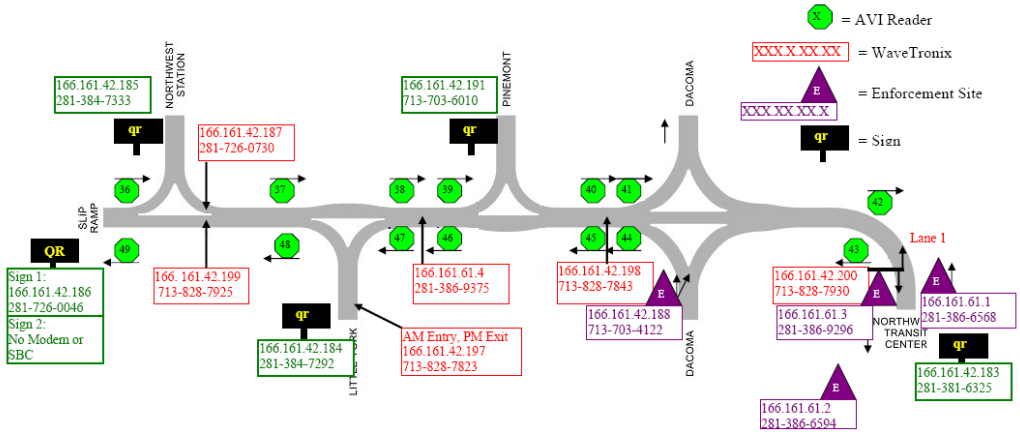

Figure 1: Northwest Freeway

Table 2: Details of Wavetronix sensor locations

No.	Sensor	Location
1	581	Northwest Station Through Lane
2	1261	Northwest Transit Center Inbound
3	1268	Northwest Station Exit Lane
4	1272	Dacoma
5	1276	West Little York Exit Lane
6	2666	Pinemont

Automatic Vehicle Identification System:

AVI speed data were collected for both the HOV lane and the GPL's for all of 2007. Vehicle speed data were aggregated into 15 minutes intervals.

Data Analysis

Data Sorting

The raw data was analyzed for erroneous data. The following list includes all the errors which were removed from raw data:

- Null values in raw data
- Volumes greater than 40 vehicles per minute per lane
- High speeds (over 100 mph)
- Speeds of 0 when volume over 0
- Volumes of 0 when speeds over 0
- Volumes and speeds of 0 when occupancy over 0
- High volumes with zero occupancy
- Identical consecutive volumes, speeds, or occupancies

While sorting data, it was found that Northwest Transit Center Inbound station (Sensor = 1261) had many entries with a volume greater than 40 vehicles per minute and it also had around 8000 entries with zero speed with volume was greater than zero. The data collected from this sensor were removed from analysis. The remaining data were aggregated into 15 minute periods.

Speed and Volume Data Analysis (Wavetronix Sensors)

Vehicle speeds and volumes for the four month period for all specified Wavetronix sensors on the HOT lane are shown in Figures 2 through 6. Dacoma and Pinemont are the only two locations which represent main corridor speed, volume and occupancy data, because all other sensors are either at an entry location or at an exit location. In all graphs, 15 minute volume is plotted on secondary Y axis.

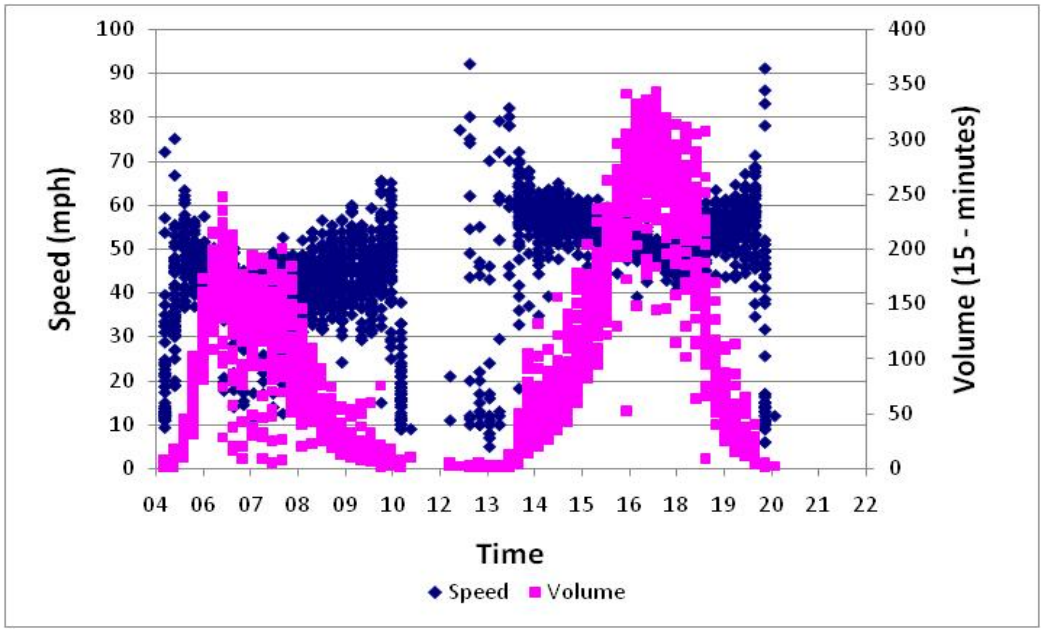

Figure 2: Speeds and Volumes at North West Through Lane

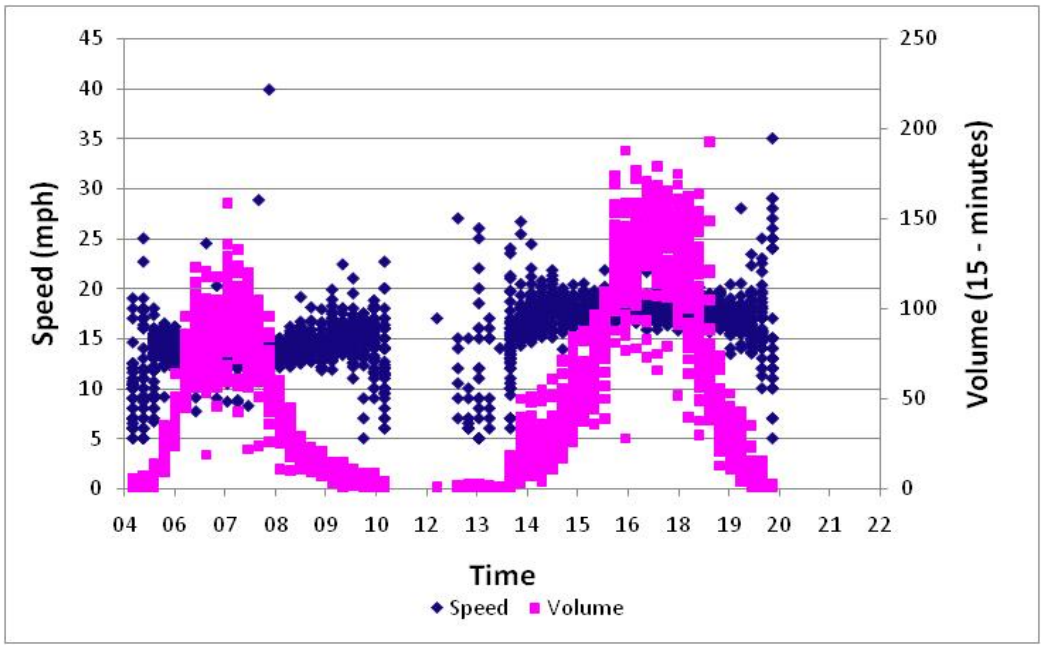

Figure 3: Speeds and Volumes at North West Exit Lane

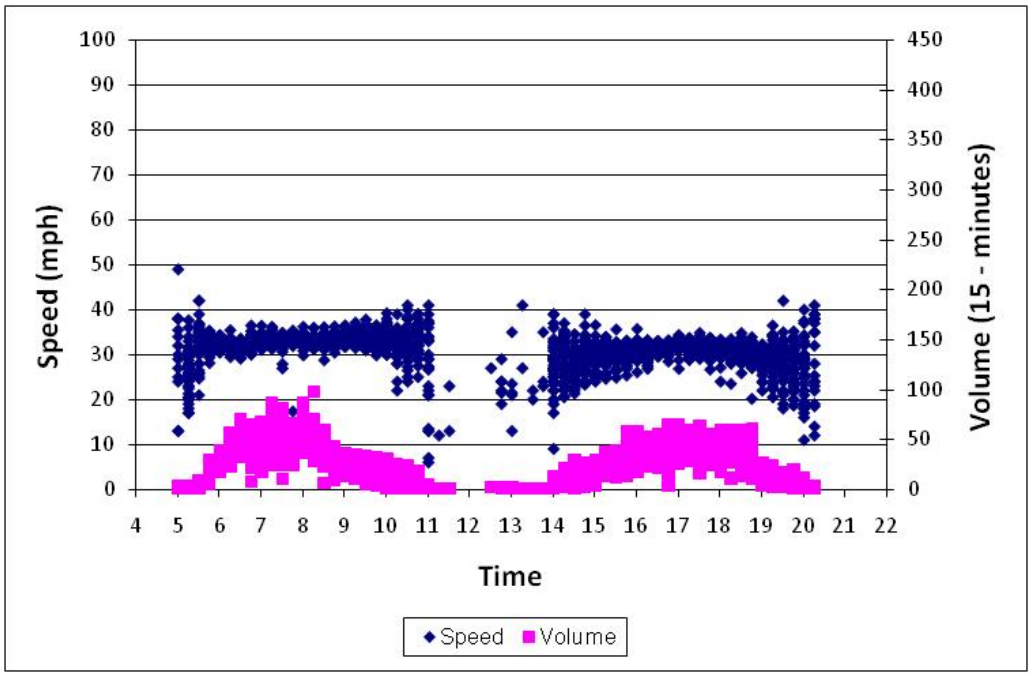

Figure 4: Speeds and Volumes at West Little York Exit Lane

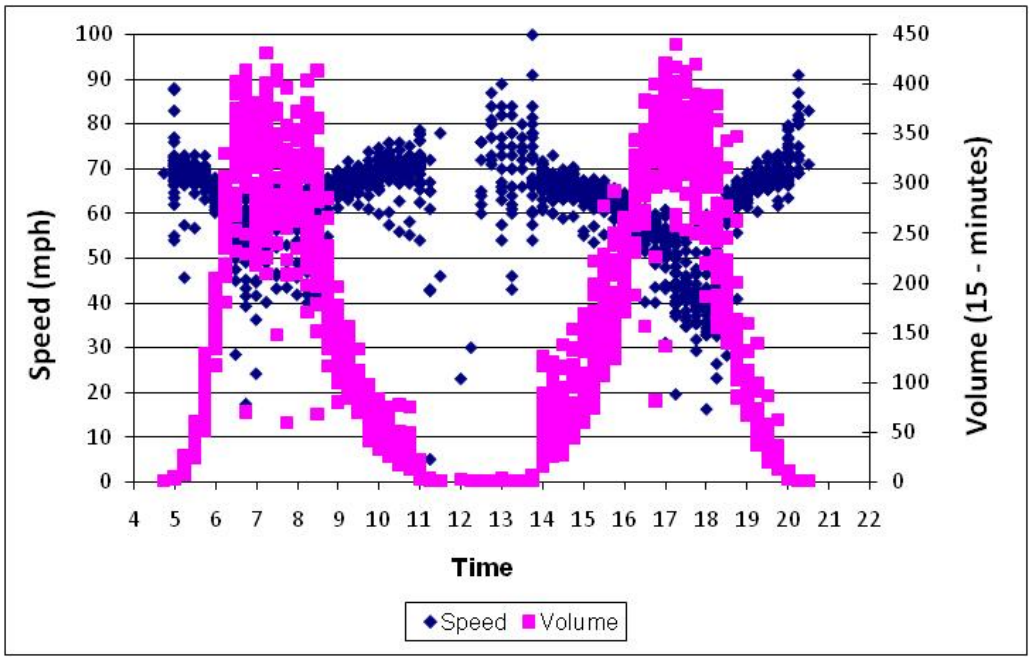

Figure 5: Speeds and Volumes at Pinemont

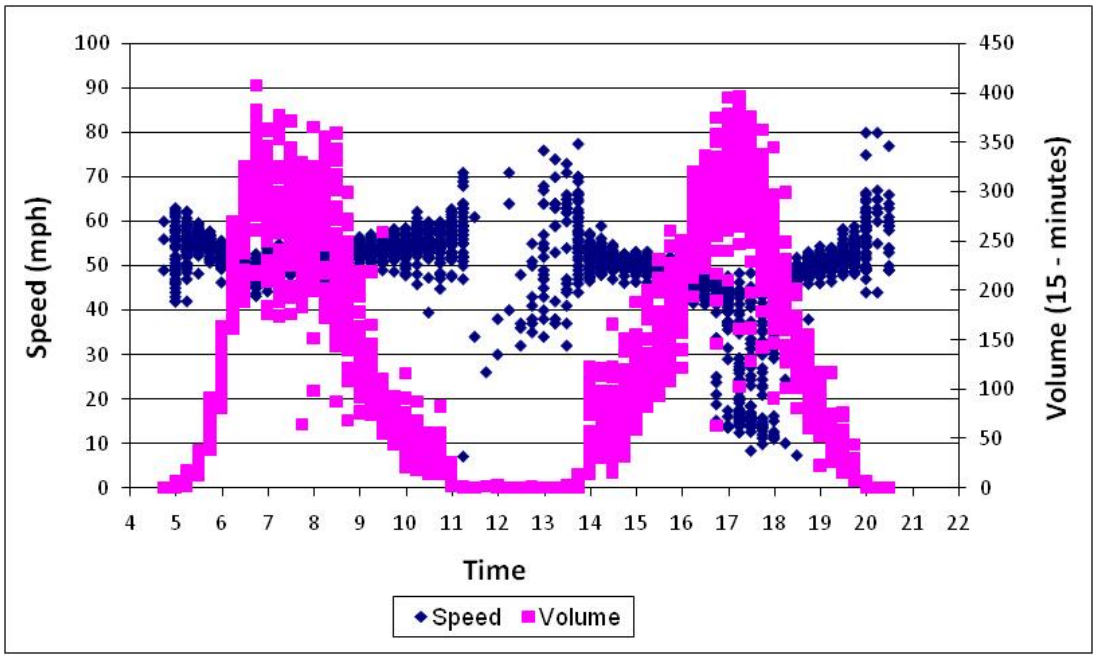

Figure 6: Speeds and Volumes at Dacoma

Further Analysis of Pinemont and Dacoma Stations

Vehicles at the Pinemont and Dacoma stations experienced very low speeds during the evening peak period. Therefore, the percentage of readings below a particular speed were calculated (see Tables 3 and 4). Note that in off-peak periods there may be slow moving maintenance vehicles.

Table 3: Speeds at the Pinemont Station

Time	Percentage of Time Speed was below			
	<50 mph	<45 mph	<40 mph	<30 mph
4:45 - 6:00	No speeds below 50 mph			
6:15	3.92	0	0	0
6:30	7.84	1.96	1.96	1.96
6:45	13.73	7.84	3.92	1.96
7:00	9.8	7.84	3.92	1.96
7:15	5.88	1.96	0	0
7:30	5.88	1.96	0	0

7:45	3.92	1.96	0	0
8:00	5.88	1.96	0	0
8:15	5.88	3.92	0	0
8:30	3.92	1.96	0	0
8:45 - 16:15	No speeds below 50 mph			
16:30	1.96	1.96	0	0
16:45	5.88	3.92	0	0
17:00	9.8	5.88	1.96	0
17:15	45.1	33.33	11.76	1.96
17:30	52.94	47.06	9.8	0
17:45	52.94	47.06	23.53	1.96
18:00	45.1	39.22	23.53	1.96
18:15	27.45	19.61	9.8	3.92
18:30	5.88	3.92	3.92	1.96
18:45	1.96	1.96	0	0
19:00 - 20:30	No speeds below 50 mph			

Table 4: Speeds at the Dacoma Station

Time	Percentage of Time Speed was below				Time	Percentage of Time Speed was bwlow			
	<50 mph	<45 mph	<40 mph	<30 mph		<50 mph	<45 mph	<40 mph	<30 mph
4:45	1.96	0	0	0	15:30	54.9	0	0	0
5:00	29.41	7.84	0	0	15:45	60.78	0	0	0
5:15	9.8	1.96	0	0	16:00	90.2	1.96	0	0
5:30	1.96	0	0	0	16:15	92.16	5.88	0	0
5:45	0	0	0	0	16:30	92.16	19.61	0	0
6:00	9.8	0	0	0	16:45	94.12	45.1	15.69	9.8
6:15	27.45	1.96	0	0	17:00	92.16	82.35	37.25	13.73
6:30	56.86	1.96	0	0	17:15	92.16	88.24	76.47	66.67
6:45	70.59	5.88	0	0	17:30	92.16	88.24	74.51	66.67
7:00	43.14	1.96	0	0	17:45	92.16	70.59	56.86	41.18
7:15	25.49	0	0	0	18:00	92.16	37.25	29.41	15.69
7:30	15.69	0	0	0	18:15	88.24	19.61	9.8	5.88
7:45	13.73	0	0	0	18:30	82.35	3.92	3.92	1.96
8:00	15.69	0	0	0	18:45	49.02	1.96	1.96	0
8:15	25.49	1.96	0	0	19:00	31.37	0	0	0
8:30	17.65	1.96	0	0	19:15	31.37	0	0	0
8:45	7.84	0	0	0	19:30	11.76	0	0	0
9:00	5.88	0	0	0	19:45	13.73	0	0	0
9:15	5.88	0	0	0	20:00	13.73	1.96	0	0
9:30	1.96	0	0	0	20:15	1.96	1.96	0	0

9:45	1.96	0	0	0	20:30	3.92	0	0	0
10:00	7.84	0	0	0					
10:15	3.92	0	0	0					
10:30	3.92	1.96	1.96	0					
10:45	7.84	1.96	0	0					
14:00	25.49	0	0	0					
14:15	19.61	0	0	0					
14:30	15.69	0	0	0					
14:45	23.53	0	0	0					
15:00	35.29	0	0	0					
15:15	39.22	0	0	0					

The Dacoma station is very close to the Dacoma Wishbone ramp and drivers generally slow down by 10 mph or so due to merging and diverging traffic. Therefore the best gauge of slow HOT lane speeds is the Pinemont Station. A significant percentage of the time between 5:15 and to 6:15 pm the average speed is less than 40 mph.

Speed Comparison with AVI Data

To further check the Wavetronix data, speeds from the both Wavetronix data and AVI data were compared. The AVI data for the westbound direction between Pinemont and Fairbanks North Houston Road was compared with data from Pinemont station for westbound direction (See Figure 7). Based on these results it would appear the WaveTronix sensor is supplying accurate speed information.

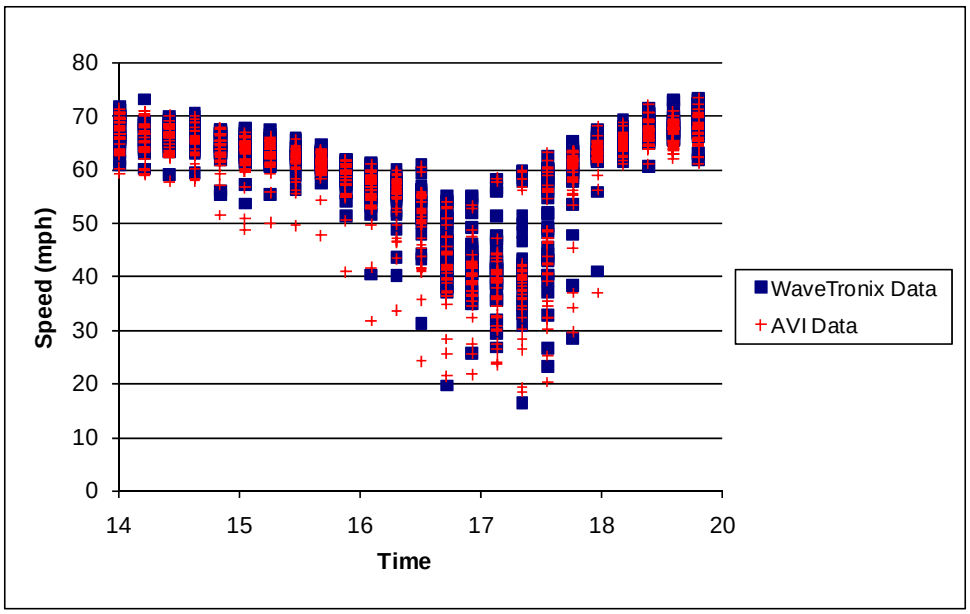

Figure 7: Speed data comparison between AVI and Wavetronix data at Pinemont and Fairbanks

Notes Regarding Wavetronix HOT Lane Data

The sensors on the HOT lane are shown in Figure 1. However the sensors at the Northwest Station through lane and the Northwest Transit Center through lane are not reporting any data (June 2009). Additionally, when accessing the data through the QuickRide server, there are times when the server stops collecting data and requires a refresh. To do this you need to

1. Access the QuickRide Server (IP: 165.95.118.14)
2. Ensure the "QR1 Pricing System Menu" is running.
3. Ensure the "QR1 Pricing Program" is running.
4. Ensure the "XML Data Converter 2" is running and HIT Refresh Data.

To collect the data from the Quickride server:

1. Open the "View WT and AVI data" page (located on the "QuickRide 1 Pricing System" page).
2. Select the dates of the data you want in the "From:" and "To:" calender spots.
3. Hit "Refresh Grids".
4. Hit "Export Data" for the data you want. It will be stored on the W: drive as a .csv file.

Alternatively, this data can be obtained through TranStar.

Volume Comparison for GPL and HOV Lane

Table 5 provides 15 minute aggregated volumes for the GPL and HOV lane for the Northwest Freeway. For calculating the averages for the GPL, TxDOT 2004 loop volumes were used and for HOV lane TxDOT volumes collected in December 2007, March 2008 and June 2008 were used. The GPL volumes remain high throughout the day, but afternoon volumes are higher on either side of the peak period. HOV lane volumes are very high during peak periods as compared to the non peak periods.

Table 5: GPL and HOV Volumes for US 290 (Northwest Freeway)

Time	GPL Volume (veh/hr)	HOV Volume (veh/hr)
5:00	2715	13
5:15	3616	60
5:30	4568	139
5:45	5184	343
6:00	5449	624
6:15	6210	1007
6:30	6126	1367
6:45	5967	1511
7:00	5705	1392
7:15	5412	1189
7:30	5145	1233
7:45	4998	1113
8:00	4970	1189
8:15	4852	1332
8:30	4796	1161
8:45	4792	863
9:00	4767	627
9:15	4963	532
9:30	4996	413
9:45	4946	343
10:00	4792	237
10:15	4867	163
10:30	4905	124
10:45	4877	73
14:00	4841	153
14:15	5265	167
14:30	5341	185
14:45	5361	309
15:00	5442	363
15:15	5154	503

15:30	5155	611
15:45	5131	728
16:00	5024	883
16:15	4599	1231
16:30	4450	1371
16:45	3950	1435
17:00	3731	1504
17:15	3378	1536
17:30	3255	1356
17:45	3331	1147
18:00	3909	989
18:15	4516	860
18:30	5134	605
18:45	5493	484
19:00	5595	301
19:15	5390	219
19:30	4981	135
19:45	4551	76

Quickride User Analysis

Tables 6 through 9 summarize Quickride usage for the I 10 (Katy Freeway) and US 290 (Northwest Freeway) for the four years starting 2006. Total numbers of users are decreasing on both freeways. For the Katy freeway, for the morning and evening periods, the numbers of average daily users decreased from 51.9 and 27.5 in 2006 to 9.0 and 4.7 in 2008 respectively. For Northwest freeway the number of average daily users decreased from 66.1 in 2006 to 31.1 in 2009.

Table 6: QuickRide Trips for 2006

		Total Number of Users			Daily Users		
Month	Number of Days	Katy AM	Katy PM	NorthWest AM	Katy AM	Katy PM	NorthWest AM
January	21	1262	735	1583	60.1	35.0	75.4
February	20	1252	771	1623	62.6	38.6	81.2
March	23	1386	794	1526	60.3	34.5	66.3
April	20	1245	602	1400	62.3	30.1	70.0
May	22	1356	682	1453	61.6	31.0	66.0
June	22	969	554	1135	44.0	25.2	51.6
July	20	719	441	1014	36.0	22.1	50.7
August	23	1193	713	1430	51.9	31.0	62.2
September	20	1292	586	1631	64.6	29.3	81.6
October	21	1180	517	1607	56.2	24.6	76.5
November	20	1186	542	1258	59.3	27.1	62.9
December	20	79	23	981	4.0	1.2	49.1
TOTALS	252	13119	6960	16641	51.9	27.5	66.1
					Total Daily Usage		145.5

Table 7: QuickRide Trips for 2007

		Total Number of Users			Daily Users		
Month	Number of Days	Katy AM	Katy PM	NorthWest AM	Katy AM	Katy PM	NorthWest AM
January	21	153	110	1316	7.3	5.2	62.7
February	20	844	334	1258	42.2	16.7	62.9
March	22	668	270	1141	30.4	12.3	51.9
April	21	486	268	1208	23.1	12.8	57.5
May	22	671	280	1260	30.5	12.7	57.3
June	21	368	356	852	17.5	17.0	40.6
July	21	359	357	700	17.1	17.0	33.3
August	23	469	393	846	20.4	17.1	36.8
September	19	461	384	985	24.3	20.2	51.8
October	23	508	384	1183	22.1	16.7	51.4
November	20	362	268	1092	18.1	13.4	54.6
December	19	175	134	879	9.2	7.1	46.3
TOTALS	252	5524	3538	12720	21.8	14.0	50.6
					Total Daily Usage		86.4

Table 8: QuickRide Trips 2008

		Total Number of Users			Daily Users		
Month	Number of Days	Katy AM	Katy PM	NorthWest AM	Katy AM	Katy PM	NorthWest AM
January	22	297	92	1168	13.5	4.2	53.1
February	21	187	97	1140	8.9	4.6	54.3
March	21	310	147	1006	14.8	7.0	47.9
April	22	411	123	1136	18.7	5.6	51.6
May	21	419	112	969	20.0	5.3	46.1
June	21	332	234	567	15.8	11.1	27.0
July	22	279	280	601	12.7	12.7	27.3
August	21	80	74	677	3.8	3.5	32.2
September	13	2	31	607	0.2	2.4	46.7
October	23	0	0	989	0.0	0.0	43.0
November	17	0	0	669	0.0	0.0	39.4
December	21	0	0	635	0.0	0.0	30.2
TOTALS	245	2317	1190	10164	9.0	4.7	41.6
					Total Daily Usage		55.3

Table 9: QuickRide Trips 2009

		Total Number of Users			Daily Users		
Month	Number of Days	Katy AM	Katy PM	NorthWest AM	Katy AM	Katy PM	NorthWest AM
January	19	0	0	568	0.0	0.0	29.9
February	20	0	0	634	0.0	0.0	31.7
March	21	0	0	614	0.0	0.0	29.2
April	2	0	0	67	0.0	0.0	33.5
TOTALS	62	0	0	1883	0.0	0.0	31.1
					Total Daily Usage		31.1

Figures 8 through 11 provide 5 minute daily average number of Quickride uses for Katy and Northwest freeways for the years 2006 through 2009. There is a significant decrease in number of QuickRide users using the facilities during the morning peak period. The number of QuickRide trips peaks during the middle of the QuickRide period and decrease to either side of the peak. It is likely that some HOV2 travelers whose time of travel is near the beginning or end

of the QuickRide period simply shifted their time of travel to non-QuickRide times and avoided the $2 toll.

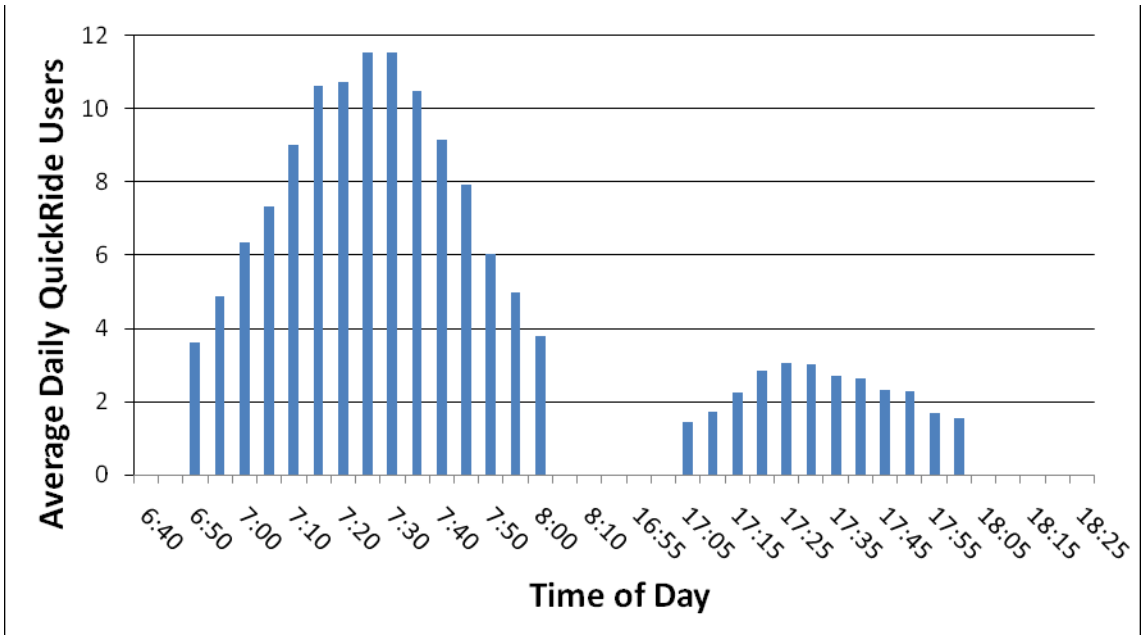

Figure 8: Quickride Use by Time of Day: Katy and Northwest Freeways, 2006

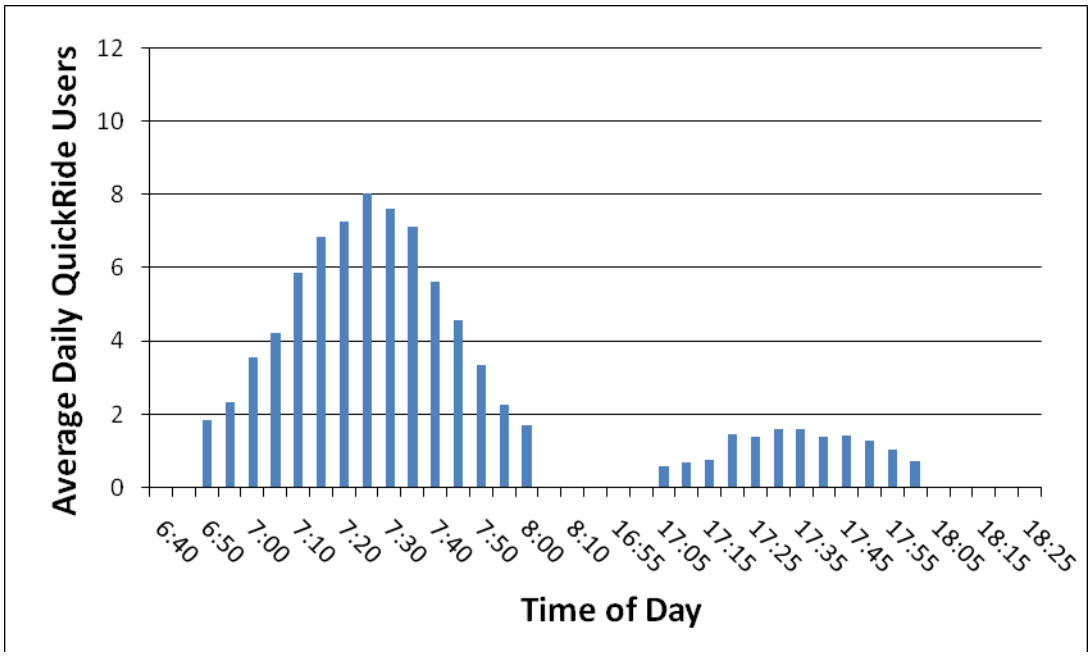

Figure 9: Quickride Use by Time of Day: Katy and Northwest Freeways, 2007

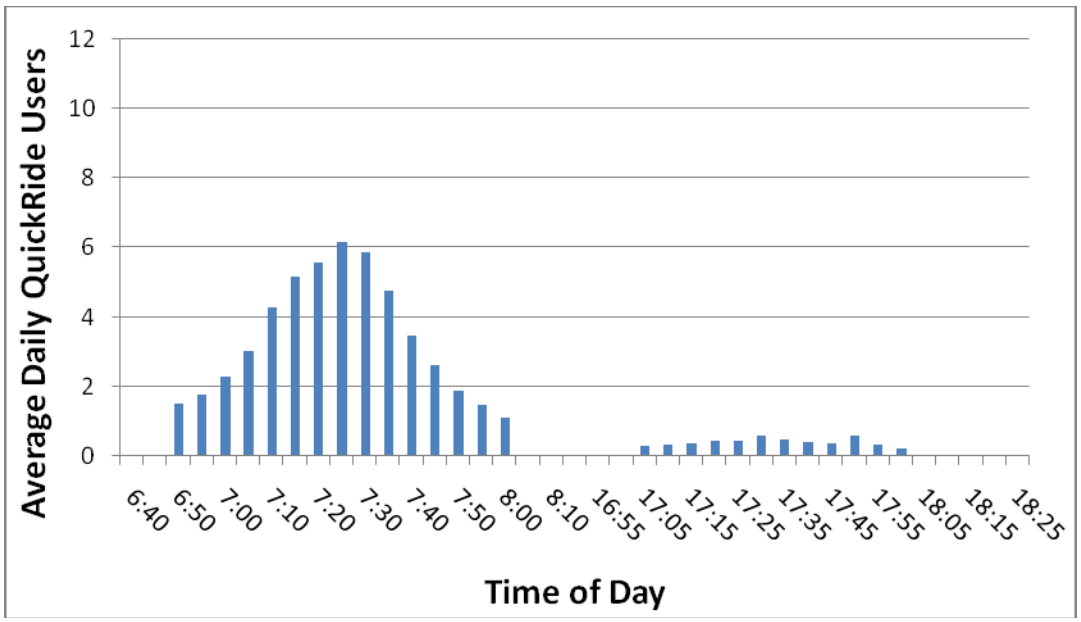

Figure 10: Average Quickride Use by Time of Day: Katy and Northwest Freeways, 2008

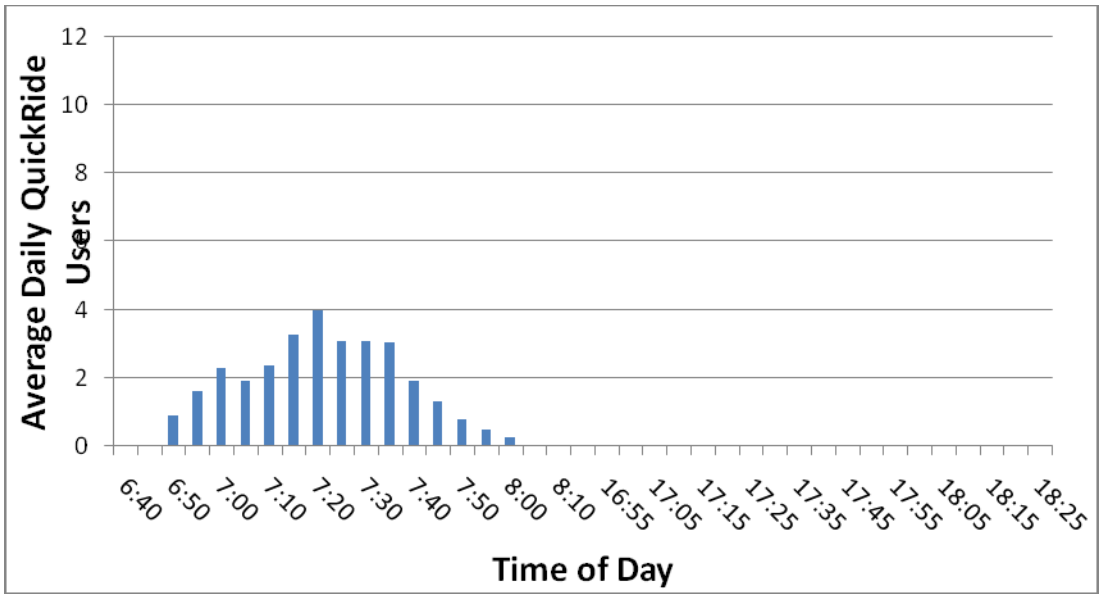

Figure 11: Quickride Use by Time of Day: Katy and Northwest Freeways, 2009

The data from Tables 6 to 9 and Figures 8 to 11 clearly show a decrease in the use of QuickRide. The reason for the recent decline on the Katy Freeway is due primarily to the new construction. QuickRide ended on Katy Freeway in November 2008 with the opening of the Managed Lanes to all HOV2+ carpools. Prior to that, the construction would cause problems collecting tag reads

from the lane. The decrease in QR use on US290 was more puzzling, as congestion on the freeway lanes has gotten worse. To examine this issue more closely we looked at transponder reads for QuickRide use over the last few years.

Analysis of TXDOT and HCTRA Transponder Reads

For this analysis all active and valid QuickRide tags (issued by either HCTRA or TxDOT (METRO)) were examined. Figure 12 represents the percentage of TxDOT QR tags which were issued in the month on the bottom axis which were read in November - December of 2007. This, especially when combined with the graph below showing HCTRA tag reads, can be used as an indicator of attrition and tag or reader malfunction. Overall, 10.2% of users with TxDOT QR tags used the system in November – December 2007, indicative of the program retention rate.

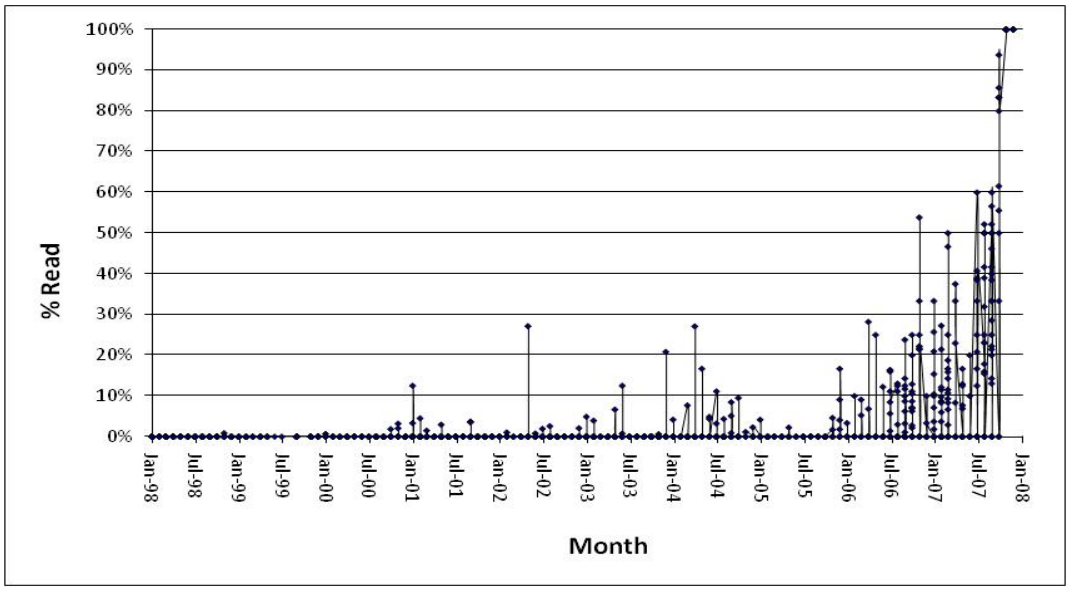

Figure 12: Percentage of TxDOT tags read in November-December 2007

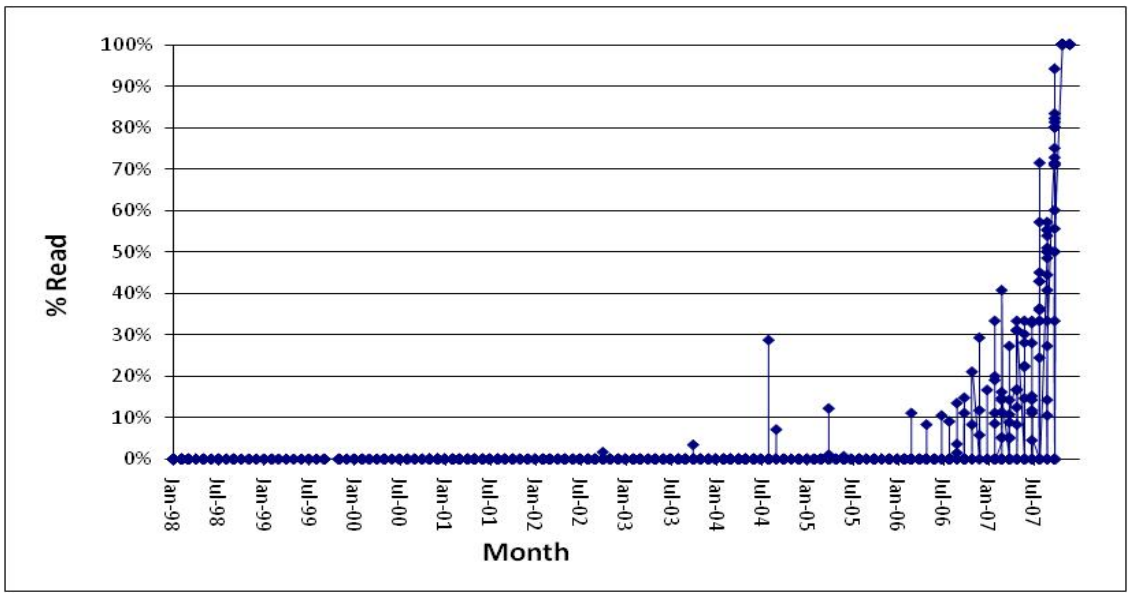

Figure 13: Percentage of HCTRA tags read in November-December 2007

Similar to Figure 12, Figure 13 represents HCTRA QR tag reads (Fig. 13). Overall, 4.8% of HCTRA QR tags used QR in November – December 2007. This number is much lower than the TxDOT tag use rate, indicating some issue with detection of users with HCTRA-issued QR tags. Furthermore, there are very few HCTRA tags more than a year old being detected. Around one year ago, HCTRA began conversion from hard-case tags to sticker type tags. The QR system may not be compatible with the sticker tags, so users with HCTRA tags may no longer be detected. Users may also have neglected to update their QR accounts after receiving their sticker tags, resulting in a drop in valid HCTRA tag reads.

Figure 14 represents the start and end dates for QR tags. Steep slopes along the base of the graph indicate low rates of new enrollment, while shallow slopes indicate rapid enrollment. Steeper slopes from the base to the upper end of the graph indicate lower attrition rates. This graph indicates that new enrollment was rapid at the inception of QR and slowed until the addition of the Northwest Freeway to the QR program. Since then, enrollment has been steady.

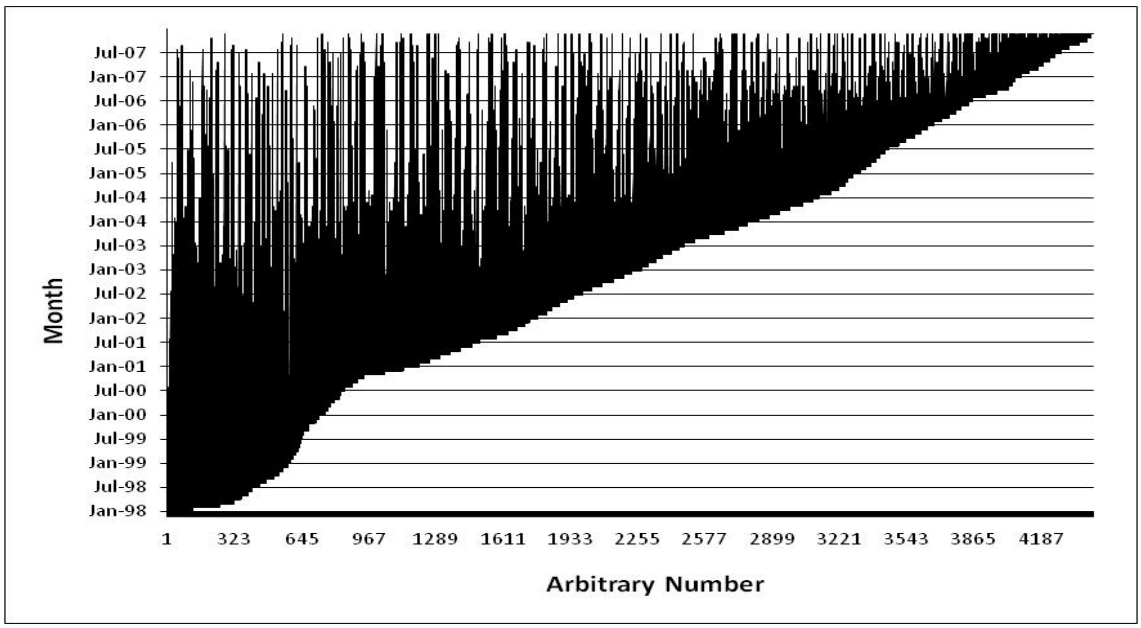

Figure 14: Start versus end date analysis for both TxDOT and HCTRA Tags

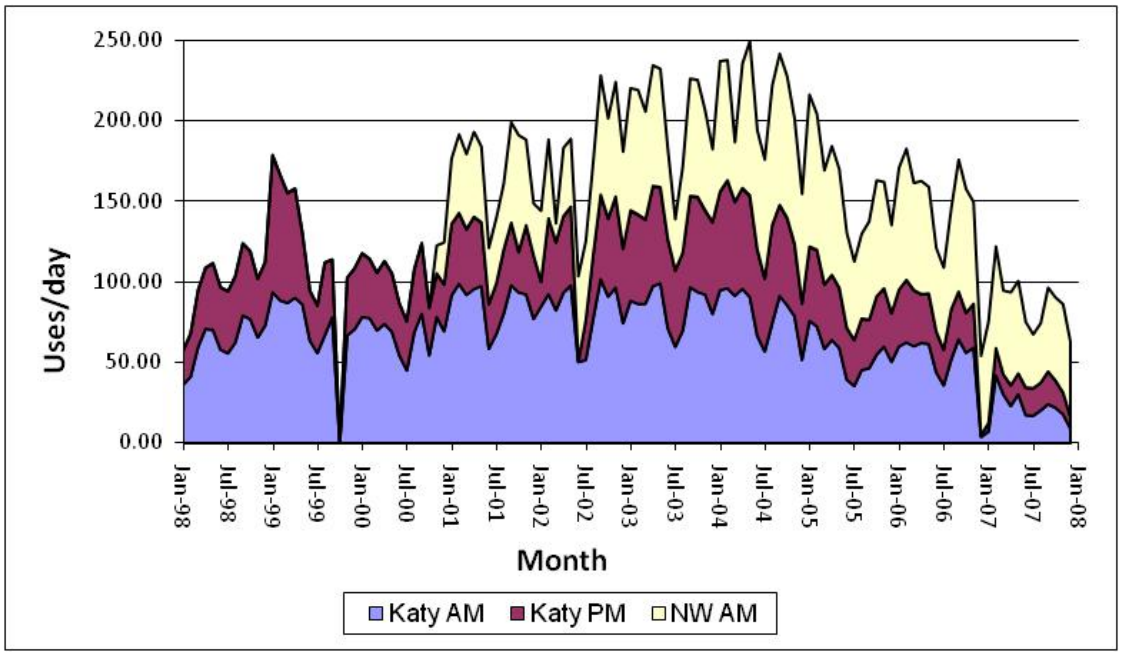

Figure 15: Daily QR usage by month for both TxDOT and HCTRA Tags

QR use appears to have gradually increased from program inception to 2004 (Figure 15). Use rates appear to have plateaued in 2004, and have been in decline since 2005. It is possible that

issues with the tags may be part of the cause of this decline in detected uses. The hard-case style tags contain batteries which last roughly three to five years. As these tags age and the batteries die, some users may replace their tags. This is especially true for HCTRA users, who are notified of tag read problems to facilitate proper toll collection. HCTRA users may not remember to notify the QR program of a change in tag. These tags would then be ignored by the QR systems, as they are not associated with a QR account. This problem may be been exacerbated by HCTRA's conversion from hard-case tag to window sticker tag. The QR system may not be able to read these tags at all, and even if it can, users may not have remembered to notify the QR program of the change in tag. This may explain the drastic decline in the number of Katy Freeway QR uses logged. Analysis similar to Figures 14 and 15 were done separately for the TxDOT and HCTRA Tags, and figures 16 through 19 shows trends observed for the same.

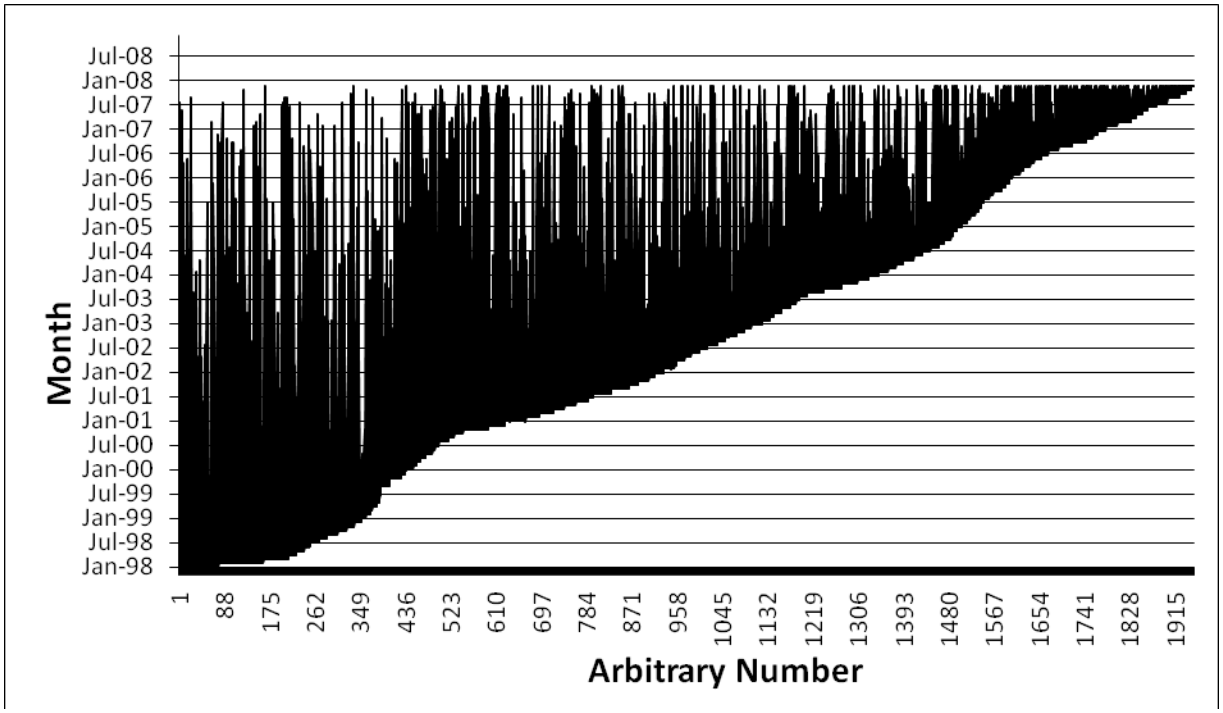

Figure 16: Daily Start versus end date analysis for TxDOT Tags

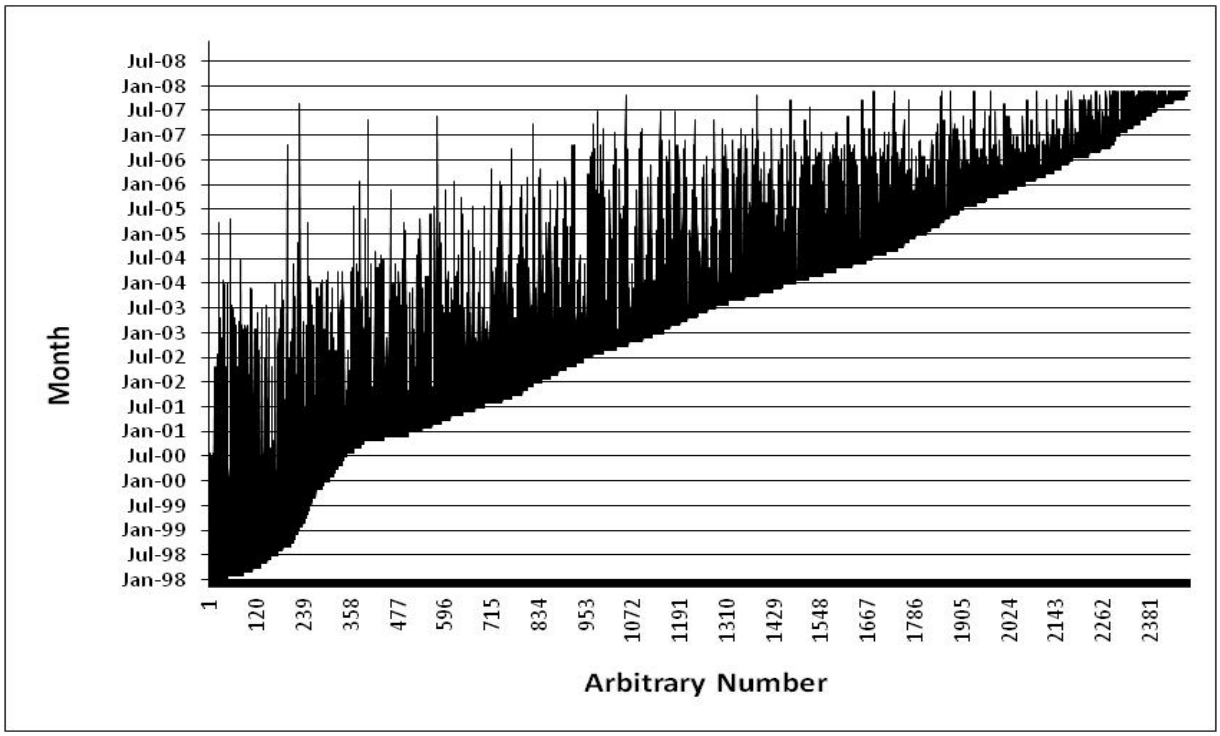

Figure 17: Daily Start versus end date analysis for HCTRA Tags

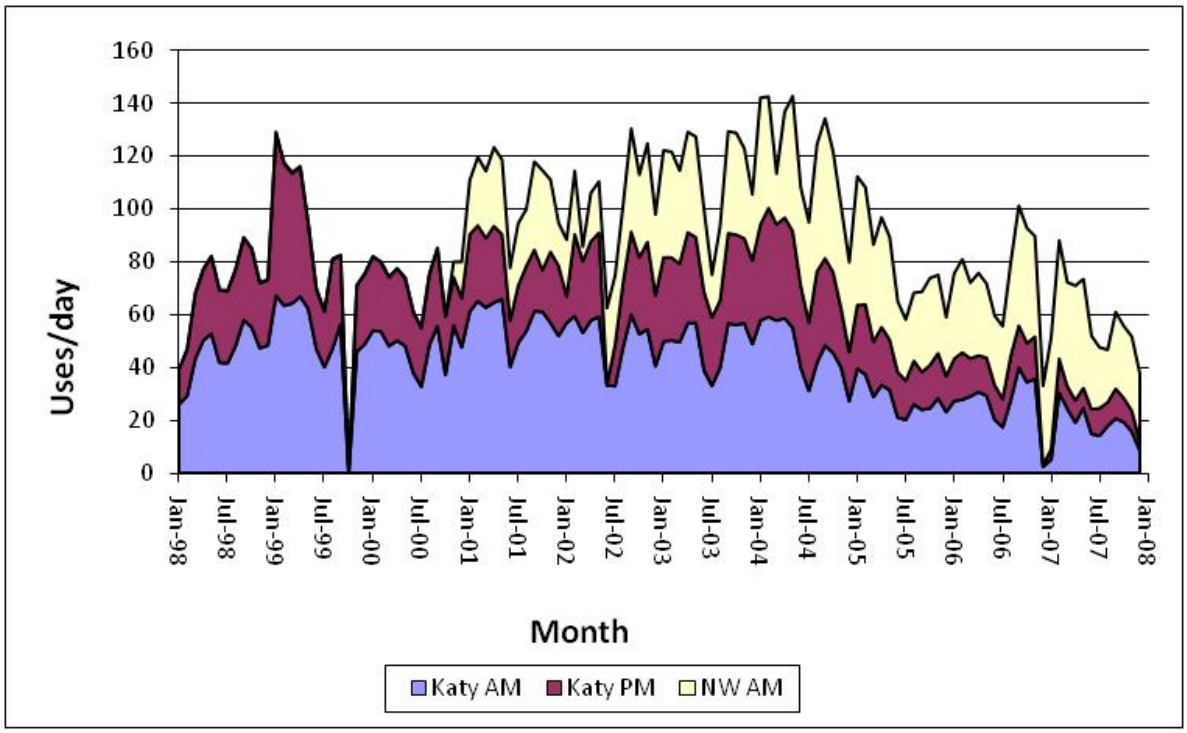

Figure 18: Daily QR usage by month for TxDOT Tags

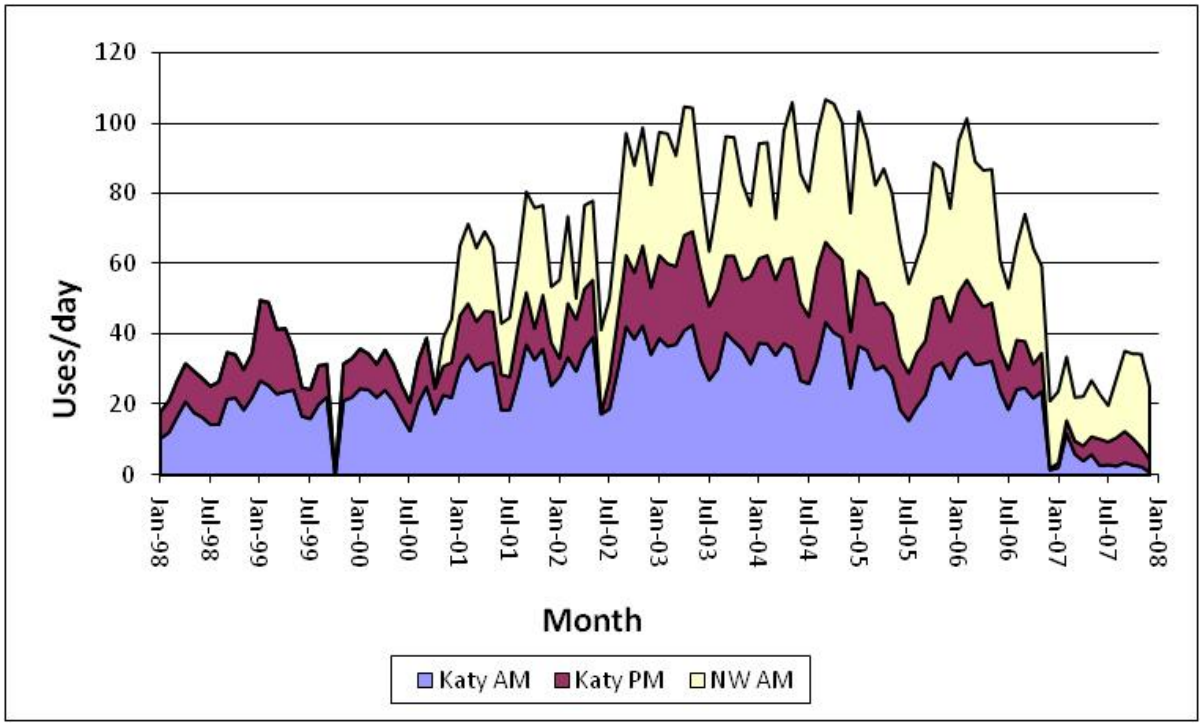

Figure 19: Daily QR usage by month for HCTRA Tags

The fact that:

1. So few tags are read taking QuickRide trips (approximately 10 percent of TxDOT tags and 5 percent HCTRA tags over November and December 2007) but
2. Retain an active account costing $2.5 per month plus
3. The age of hard case tags and
4. The swap to sticker tags on the HCTRA system.

All add up to drivers still using QuickRide on US290, but not getting charged for it.

Travel Time Savings Estimation

To further analyze the performance of the HOT lane, travel time savings were estimated for the HOT lane. Figures 20 and 21 explain the speed variation for both the HOV lane and GPL. 15 minute aggregated speed data were used for this analysis. For US290 Northwest, 15 data from May 2008 through April 2009 were used. For the Katy Freeway, GPL speed data from November 2008 through May 2009 were used and for HOV lane, data from April 20, 2009 through May 20, 2009 were used. Holidays and weekend data were excluded from the analysis.

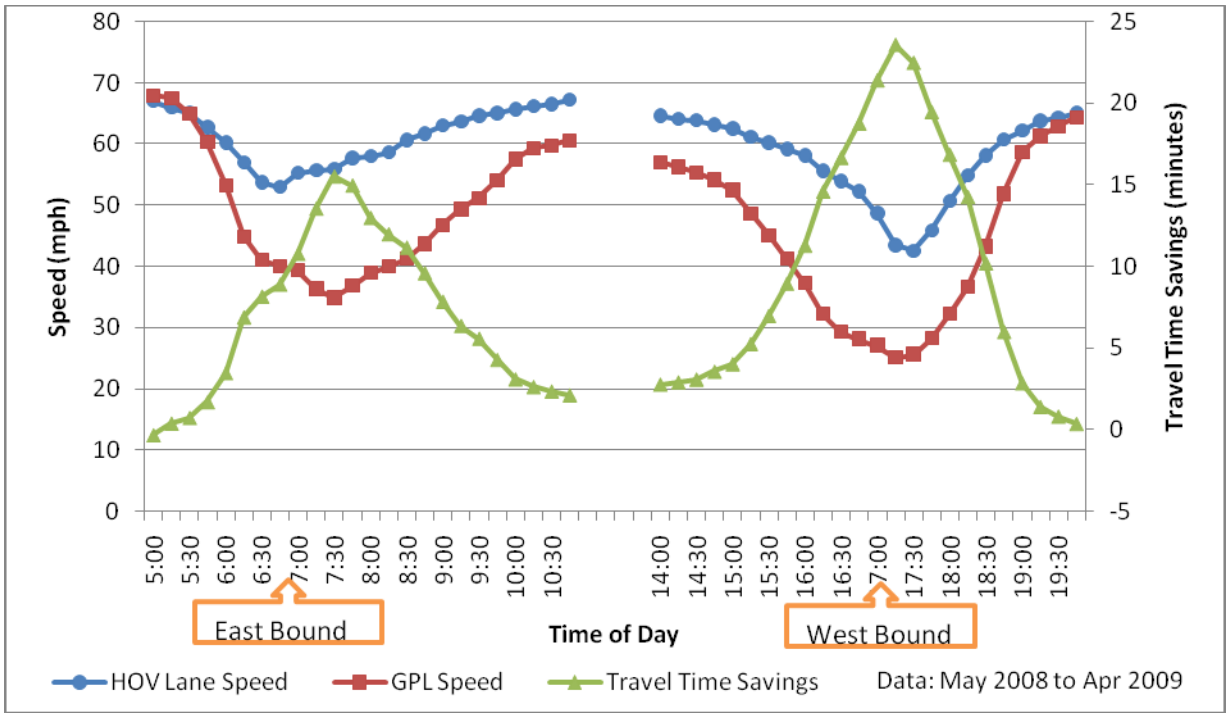

Figure 20: Travel Time Savings Estimation for US 290 Northwest Freeway

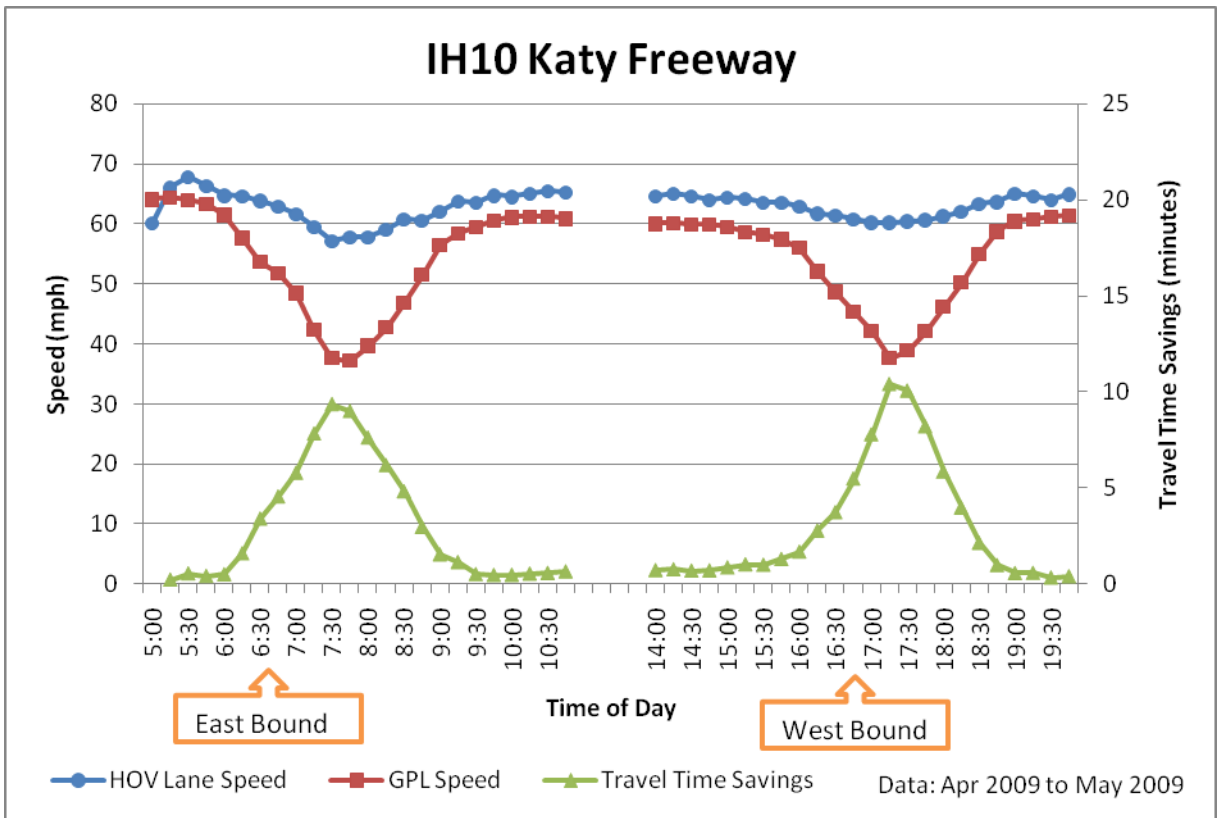

Figure 21: Travel Time Savings Estimation for IH 10 Katy Freeway

For both freeways, there is significant speed drop during the peak periods. Travel time savings peak at 7:30 am for the morning period and at 5:30 pm for the evening period. But the travel time savings are higher for the evening peak as compared to the morning peak period. The Northwest Freeway has the highest travel time savings for both peak periods as compared to Katy Freeway.

Travel Time Reliability Analysis

Travel time reliability analysis was conducted for the US 290 Northwest Freeway and the Katy Freeway. The same dataset as mentioned in the above section was used for this analysis. This analysis is based only on the number of vehicles had transponders and used these freeways. Figures 22 and 23 explain speed variation for both freeways. As expected, HOT lane has highest percentage of observations between 60 mph and 64 mph. on the other hand, GPL speeds are wide spread. For US 290 Northwest Freeways, a significant percentage of observations are below 40 mph. Katy Freeway GPL are operating a little better as compared to Northwest Freeway, as a significant percentage of speeds are above 40 mph.

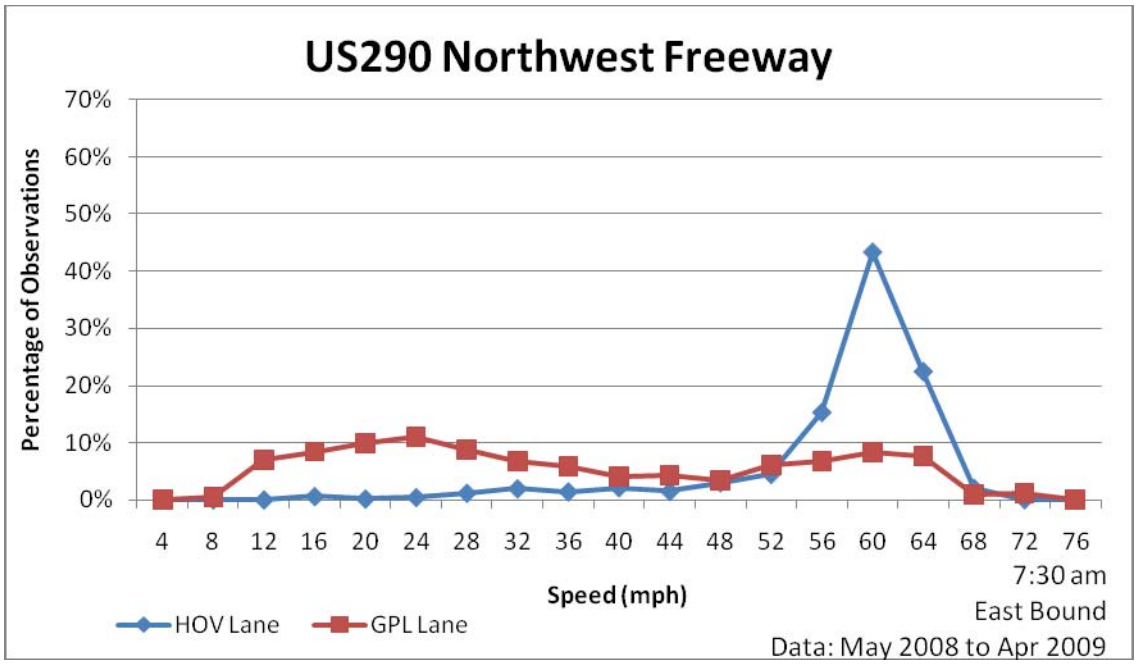

Figure 22: Speed Variation for US 290 Northwest Freeway

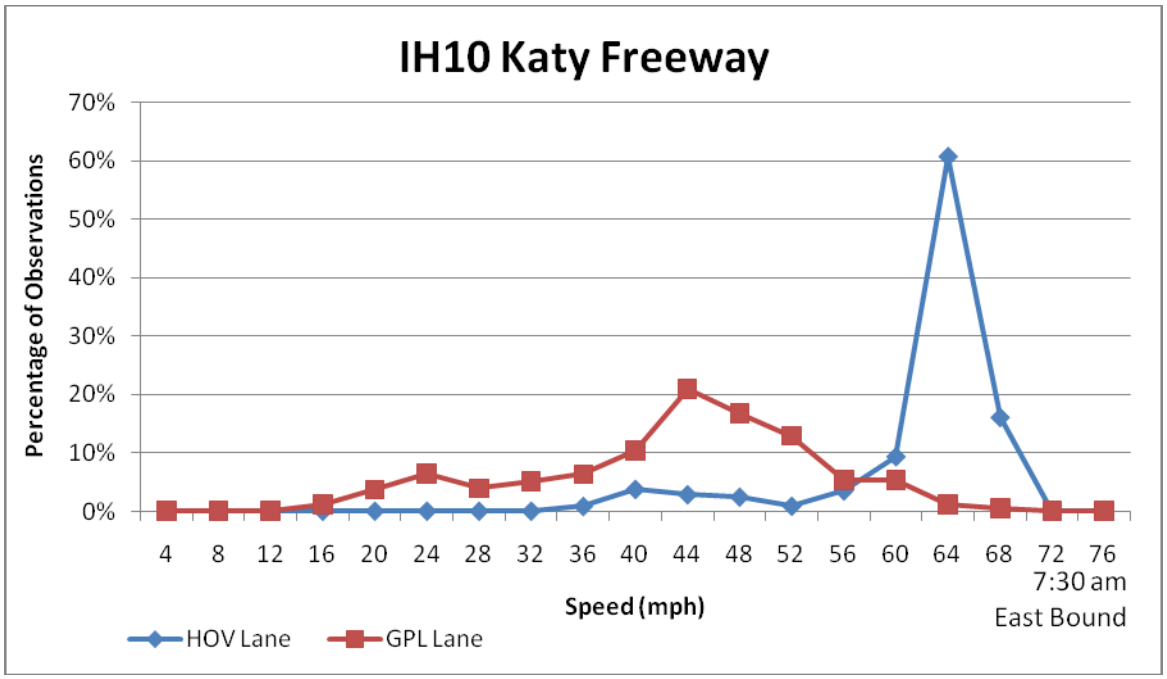

Figure 23: Speed Variation for IH 10 Katy Freeway

HOT Lanes Violation Rate Analysis

HOT lane violation rates were estimated for all six freeways with HOV lanes. Katy and Northwest Freeway results are presented in Figures 24 and 25. The violation rates for Katy Freeway and Northwest Freeway were considerably higher than the other freeway HOV lanes. For the Katy Freeway and the Northwest Freeway violation rates were higher in the morning (close to 40 percent on each) as compared to the evening (close to 30 percent on Katy and 11 percent on Northwest). For the Gulf Freeway, Southwest Freeway, North Freeway and Eastex Freeway violation rates ranged between 2 percent to 15 percent. Thus, during times where HOV2s are allowed to travel on the HOV lanes there is a relatively low violation rate, but when occupancy is restricted to HOV3+ the violation rate increases dramatically. This is due, at least in part, to the many HOV2 vehicles traveling on the HOV lanes during those times who are registered for QuickRide but are not paying a toll. Since they are not being recognized by the system as legal QuickRide participants they were categorized as violators.

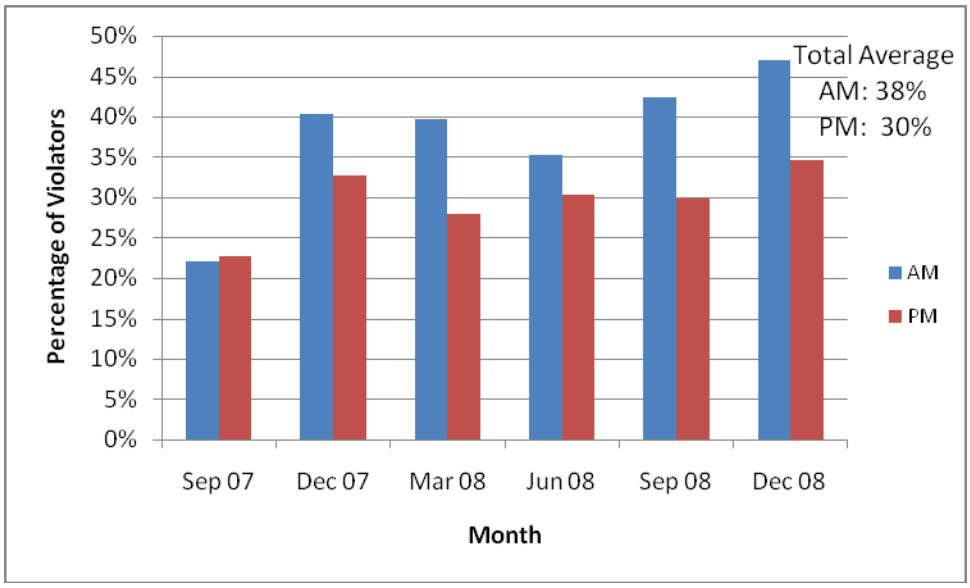

Figure 24: HOT Lane Violation Rate on IH 10 Katy Freeway

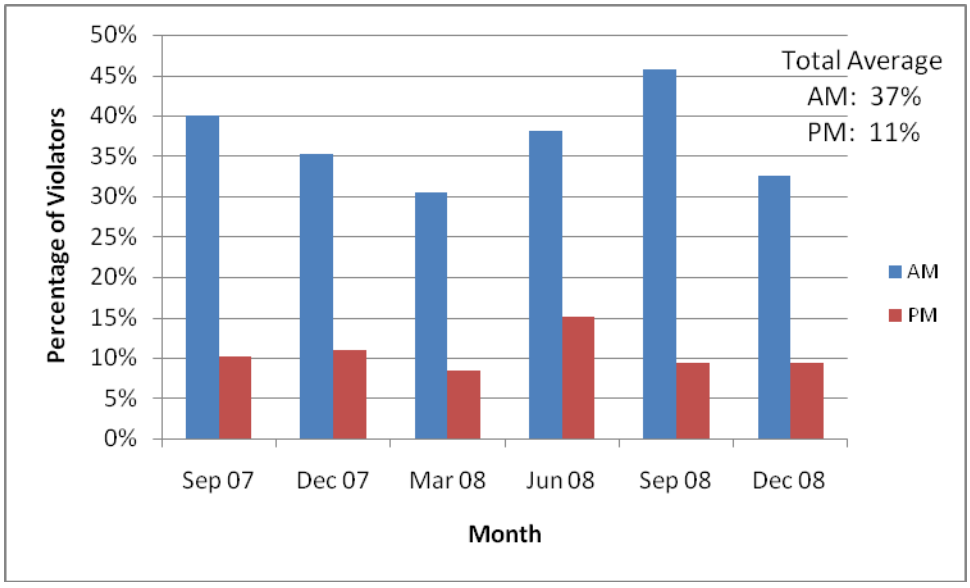

Figure 25: HOT Lane Violation Rate on US 290 Northwest Freeway

Pricing and Usage of Katy Freeway Managed Lanes

The Katy Freeway was being reconstructed during most of the time period of this HOT lane project. In November of 2008 the freeway reconstruction was nearly complete and the single-reversible HOT lane was now opened as a 4-lane (two per direction) HOV lane in the middle of the Katy Freeway. Several months later, in April 2009, the lane switched to become a HOT lane. HOVs (two or more occupants) were allowed to travel for free during HOV hours (Monday

through Friday 5 am to 11 am and 2 pm to 8 pm). HOVs had to pay the standard toll rate at other times. The standard toll rate (for SOVs) varied based on the time of day. To travel the full 12-mile length it would cost $4 in the peak, $2 during shoulder hours, and $1 in the off-peak.

During the later stages of this project data from the Katy Managed Lanes and Freeway Lanes were collected using portable WaveTronix devices. This proved very valuable in gaining data on the usage of the Katy Managed Lanes. The trailer with the WaveTronix devices was located approximately one mile west of the Wirt tolling plaza. Therefore, many of the vehicles in the two Managed Lanes are likely in their correct lane for the tolling station – inside lane for HOVs and outside lane for toll vehicles. The data in Figures 26 to 29 are from August 19 to September 9, 2009 excluding weekends and data is aggregated into 15-minute periods. As can be seen in the graphs, a considerable number of travelers are willing to pay to use the lanes despite relatively modest travel time savings.

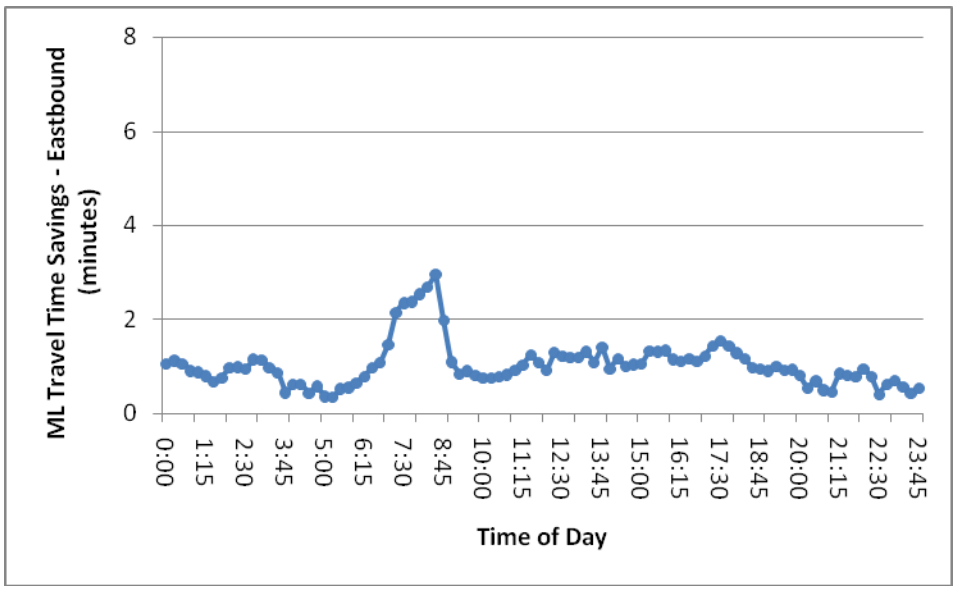

Figure 26: Eastbound Katy Managed Lanes Travel Time Savings

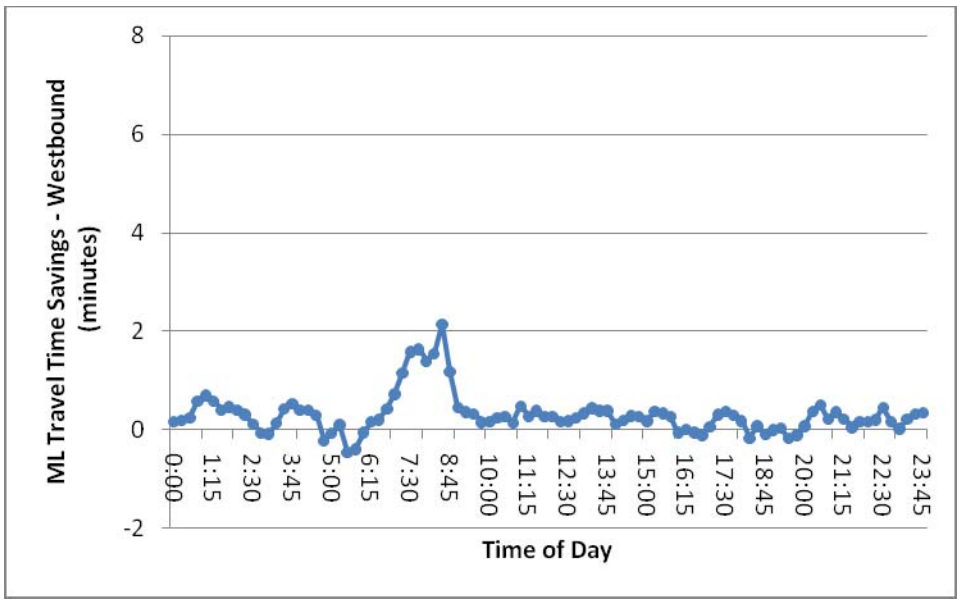

Figure 27: Westbound Katy Managed Lanes Travel Time Savings

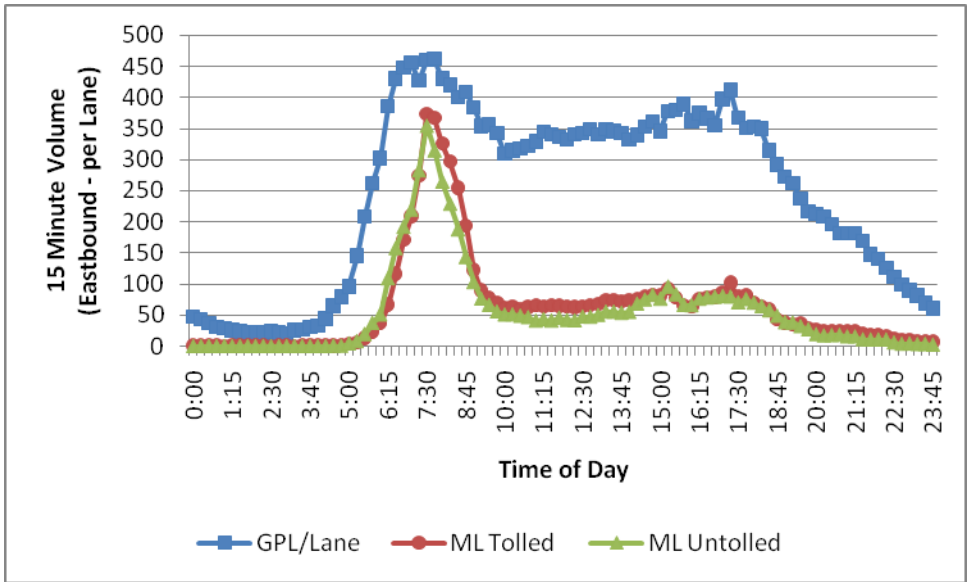

Figure 28: Eastbound Katy Managed Lanes Traffic Volumes

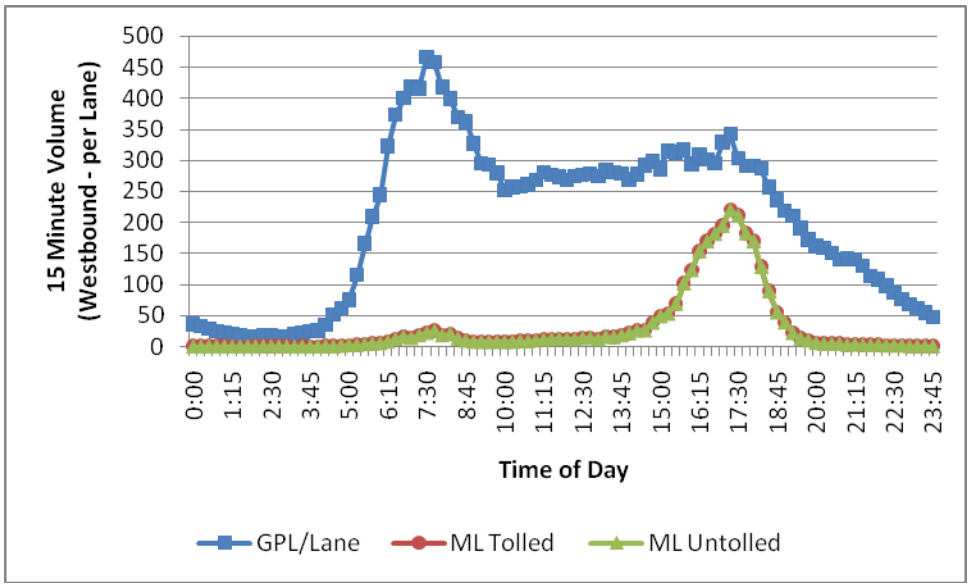

Figure 29: Westbound Katy Managed Lanes Traffic Volumes

Conclusions

This task (task number one) focused on collection of data related to the use of HOT lanes in Houston. Due to the reconstruction of Katy Freeway (I-10), and many of the monitoring systems on that freeway not functioning, most efforts were on the collection of data from the Northwest Freeway (US 290).

Vehicle speed data were obtained by two methods: WaveTronix sensors and Automatic Vehicle Identification (AVI) readers. The WaveTronix sensors collect data at a specific location and thus provide a spot speed. Based on these data it is clear that traffic speeds during the afternoon rush hour on the US 290 HOT lane often drop below 45 mph. The AVI readers collect information on when a vehicle passes a specific point on the HOT lane. The average speed of the vehicle between two of these points can be calculated using this information. These speeds corresponded well to the WaveTronix speed and provided confidence in the speeds collected.

Data on speeds in the general purpose lanes (GPLs) was also collected using AVI readers. In comparing the speeds on the GPLs and the HOT lanes it was clear the HOT lanes offered a much more reliable trip. Speeds on the US 290 HOT lane were generally between 56 mph and 66 mph, while the GPLs ranged from 12 mph to 64 mph. Katy Freeway speeds were similar. This lead to considerable travel time savings on the HOT lanes, exceeding 20 minutes in the afternoon on US 290.

Despite the significant travel time savings and reliability advantages of the HOT lanes there has been a steady decrease in QuickRide *use* since 2005. Part of this decrease was due to the Katy

Freeway no longer being part of QuickRide – but that only happened in late 2008. Note that *enrollment* in QuickRide is still very high. What appears to be happening is that users with HCTRA tags are not informing METRO of their new tag numbers (due to the conversion to sticker tags this is most users), and many users with TxDOT tags have batteries that are dead.

Finally, there continues to be a significant number of violators (low occupancy vehicles) on the HOV lanes. This is particularly true during time periods when the lanes require HOV3+ occupancy – partially due to registered QuickRide patrons who are not paying their toll. During time period with HOV3+ requirements violation rates are approximately 30 to 40 percent, where other times violation rates are below 15 percent. The exact number is difficult to determine due to difficulties counting people in fast moving vehicles.

References

1. Burris, M.W., and J. Appiah. 2004. An examination of Houston's QuickRide participants by frequency of QuickRide usage. Accepted for publication in *Transportation Research Record.*
2. Sullivan, E. 2000. Continuation study to evaluate the impacts of the SR 91 value-priced express lanes: Final report. Retrieved July 9, 2003, from the Department of Civil and Environmental Engineering, California Polytechnic State University at San Luis Obispo Web site: http://ceenve.calpoly.edu/sullivan/sr91/sr91.htm.
3. Supernak, J., C. Kaschade, D. Steffey, and G. Kubiak. 2001. I-15 Congestion Pricing Project, monitoring and evaluation services, Phase II Year Three traffic study. Retrieved June 10, 2003, from San Diego's Regional Planning Agency Web site: http://www.sandag.org/fastrak/pdfs/yr3_traffic.pdf.
4. Value Pricing Homepage. 2004. Retrieved February 6, 2004, from the Web site: http://www.hhh.umn.edu/centers/slp/projects/conpric/index.htm.