

HOT LANE ENFORCEMENT STRATEGIES

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HOT LANE ENFORCEMENT STRATEGIES

The purpose of this research is to develop and examine techniques and technologies for effectively enforcing the lanes without adversely affecting HOV lane flow. The following technical memorandum outlines the research methodology and summarizes the results.

SCOPE OF RESEARCH

HOT lanes are limited-access highway lanes that provide free or reduced cost access to qualifying high occupancy vehicles (HOV) and also provide access to other paying vehicles not meeting passenger occupancy requirements. HOT lanes utilize sophisticated electronic toll collection and traffic information systems.

High occupancy vehicles are allowed to use the lane for free. Single occupancy vehicles or carpools with fewer occupants than the requirement, have to pay a toll. In addition, the proposal is based on automated electronic tolling. This combination of factors makes HOT lane enforcement a significant challenge.

Enforcement for HOT lanes includes the ability to determine if the vehicle has enough occupants to drive for free or with a discount rate, if it needs to pay a toll, or if it is an exempt vehicle. This makes HOT enforcement more complicated than the normal HOV enforcement because of the integration of a variety of conditions.

The research examines a number of enforcement-related issues as follows:

- Facility-specific enforcement plans for the Houston HOT network.
- Violation rates for current HOV operation
- Information from other HOT lane projects related to enforcement
- Safety data on reduction of shoulders to accommodate enforcement areas Current activities in the area of automated enforcement for occupancy

METHODOLOGY

The following information was collected, reviewed and analyzed for this task.

Enforcement Plans

The HOT enforcement plan for each freeway was created taking into account the entry and exit locations of the current HOV system. Using METRO's HOV guide together with several field reconnaissance trips through the network, a diagram for each freeway was produced.

Vehicle counts were attached to the diagrams to help with the identification of target locations and enforcement points throughout the freeways. The vehicle counts are the most current performed by TTI Houston on the HOV lanes and were performed for each exit/entrance ramp in February 2009.

METRO provided comments on the enforcement proposal, which proved useful in aligning the review with the proposed HOT operating concept.

The TTI team drove through each freeway, stopping in spots that could be modified to accommodate an observation location or enforcement area. The areas were analyzed to determine if a booth and two declaration lanes fitted in the available space in the case of observation areas, and if there was enough space to accommodate two detained vehicles safely in the case of enforcement points.

The enforcement plan assumes several things based on METRO's concept of operations:

- Vehicles that meet the occupancy requirement will pass by an observation booth where visual verification will be made
- Vehicles that do not meet the occupancy requirement are to be charged at the beginning of their trip by passing the observation area through the toll declaration lane
- The toll charged will be the same at every entry location without depending on distance travelled
- Observation agents will have a way to describe the violating vehicle to enforcement officers stationed after that point to detain it and,
- Enforcement officers will have the technology to read the transponder and re-check if the vehicle is or is not a violator.

It is also important to note that many of the recommendations given on this task are consistent with FHWA's *HOV Lane Enforcement Handbook (1)*.

Description of Houston HOV facilities

Current HOV facilities in Houston are single-reversible lanes, which are separated by concrete barrier from the general purpose lanes.

The lane is located in the middle of each freeway connecting with park & ride locations, transit centers or specific roadways. The different types of ramps at each exit/entrance location do not disrupt the general purpose lanes' flow. Slip ramps are generally located at the beginning/end of each HOV lane.

The hours of operation for the HOV lanes considered are currently from 5:00 to 11:00 a.m. inbound and from 2:00 to 8:00 p.m. outbound. They all have a 2+ occupancy requirement except for the Northwest freeway that has a 3+ requirement from 6:45 to 8:00 a.m.

QuickRide Program – Enforcement

The QuickRide program allows drivers with a single passenger to use the Northwest Freeway HOV lane during peak periods by paying a \$2.00 toll each way. This gives the opportunity to people that are not able of forming a 3+ carpool to use the lane. This congestion mitigation tool makes use of the excess capacity that HOV lanes commonly had. It is important to note that the QuickRide program is not available to SOVs.

Enforcement becomes complicated since the same vehicle can sometimes be used as a two person carpool and others as a 3+ carpool. If the vehicle has three or more occupants, then the transponder can be removed and stored in a shield pouch that prevents the reading and therefore no charge is made to the QuickRide account.

Houston METRO has been the responsible of enforcement for the QuickRide program. Officers verify occupancy and look for a QuickRide hangtag. If they found a violator, they issue a warning, fine or citation depending on the case.

METRO HOT Proposal for Enforcement

METRO’s proposal is based on the need to mitigate traffic congestion on roadways without constructing additional lanes. The conversion from HOV to HOT corridors is planned to maximize the use of the lanes, help improve air quality and conserve fuel (2), (3), (4).

The proposal includes the HOV-HOT conversion on the following freeways:

- I-45 North Freeway
- I-59E Eastex Freeway
- I-45S Gulf Freeway
- US 59 Southwest Freeway
- US 290 Northwest Freeway

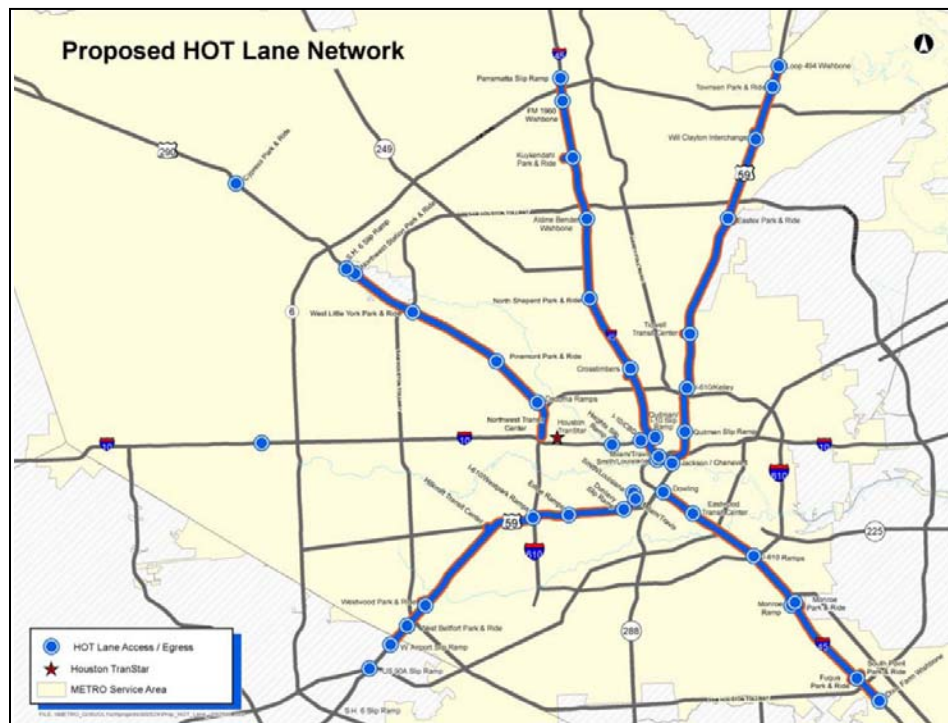


Figure 1. Proposed HOT Lane Network (3)

Occupancy violations, speeding and other moving violations will be enforced by the METRO Police. Officers will be in charge of patrolling and verifying the occupancy requirements in specified booth locations. They will be observing the declaration lanes from the inside of booths, with observers positioned randomly at individual booths. The presence of an observer in a booth will not be obvious from the vehicle, so drivers will never be certain if enforcement officers are present. This will allow fewer resources than staffing observation areas constantly. If they identify a violator they will send the information to the police officer at the next enforcement point. If they suspect a violation they can check the video recordings to verify it.

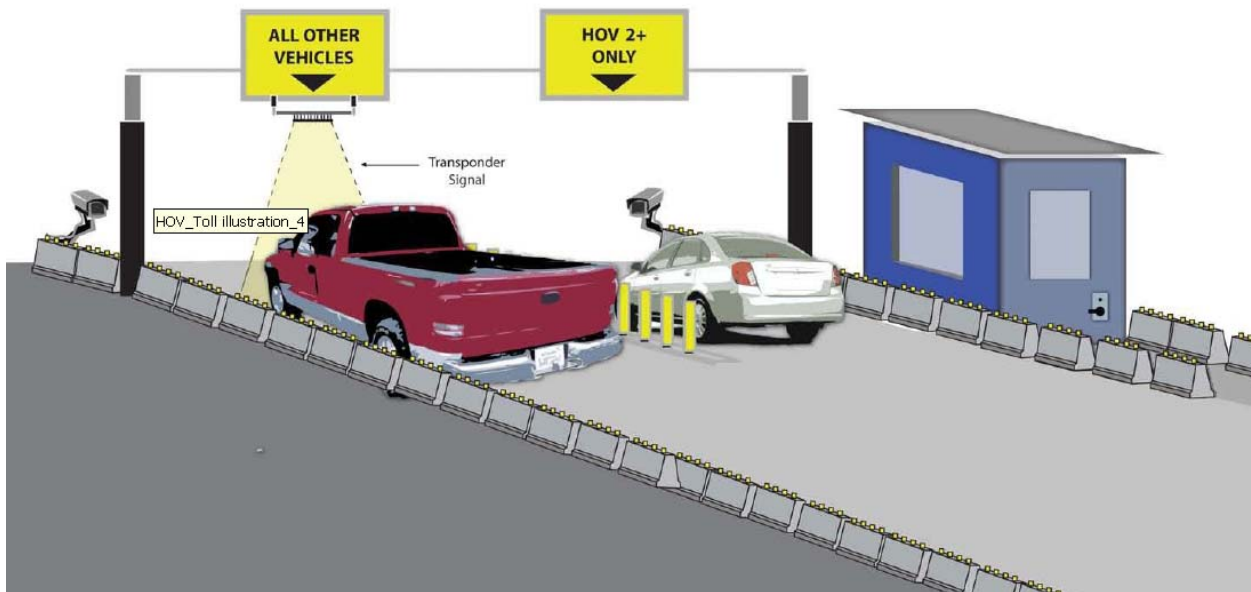


Figure 2. Illustration of Observation Area (2)

Self-enforcement (HERO program)

Self-enforcement involves self-regulation by HOV lane users and motorists in the general-purpose lanes. This technique is usually used with other approaches, rather than as the only enforcement strategy. The HERO program of self-enforcement was first developed in Seattle, Washington. It uses signs and other communication techniques to provide users and non-users with a telephone number they can call to report managed lane violators. Although the program has not had any impact on violation rates, it continues because of favorable public opinion. The HERO hotline is administered by King County Metro and funded by the Washington State Department of Transportation.

The individuals anonymously report the sighting of a violator and give the license number, time of day, location, and any other supporting information to the HERO telephone operator. Two dedicated full-time WSDOT staff members handle calls and create summaries of aggregated motorist reports. The vehicle data are checked for accuracy in the vehicle registration files, and

if they are correct, an information brochure providing information on proper use of the HOV facility, along with a warning notification from the Washington State Department of Transportation, is mailed to the vehicle owner. Violators who are reported multiple times first receive a detailed warning from WSDOT that identifies the location and time of the observed violation. This is followed by a warning from the Washington State Highway Patrol if the violator is reported three or more times.

The tracking of repeat violators and the active participation by enforcement agencies in the notification process are some of the key features contributing to the success of the program. WSDOT staff prepares monthly summaries of “violation hot spots” based on citizen reports. The Washington State Patrol receives these summaries on a regular basis and uses them to more efficiently deploy enforcement resources. In 2004, the HERO education program received nearly 36,000 citizen reports of HOV violations, an increase of 13 percent over 2003. Less than 3 percent of violators reported in 2003 were reported a second time, and fewer than 2 percent were reported three or more times.

The success of the HERO program in Seattle led to the development of similar programs in Houston, Texas, and the Washington, D.C. area, including Northern Virginia.

The Virginia Department of Motor Vehicles (DMV) launched a peer enforcement program for the northern Virginia HOV lanes in 1989. The program allowed motorists to call a hotline when they witnessed another motorist violating the HOV restrictions. The first offense earned the violator a friendly letter from the DMV with information on HOV restrictions and other educational information. A second violation resulted in a somewhat more forceful letter, and the third violation yielded a letter warning the violator that they could be ticketed if they continued to violate the HOV restrictions. For the first six months or so the program was very successful, with violation rates going from approximately 40 percent to around 10 percent. However, violators quickly caught on to the fact that there were no teeth behind the warning program, and violations quickly returned to their previous level. After two years, the peer enforcement program was disbanded due to budget cuts.

A HERO program of self-enforcement has also been operational in the Houston area for over 15 years. The program consists of a dedicated phone number that is available for motorists to call and report a violator on any of the HOV lanes. It is an automated system that requires motorists to leave a message about the reported violator. METRO transit police mail a letter to the reported violator warning them of the consequences of violating the HOV lane requirements. Houston’s program, while still operational, suffers from the same deficiency as Virginia’s effort. Violators do not perceive the warning notices to be credible in terms of enforcement consequences. Anecdotal evidence suggests that the automated reporting system serves an unintended secondary role as a feedback mechanism for frustrated legitimate HOV lane users.

It has been found that reporting systems handled by live operators are preferred over automated systems. Also, staffing resources should be able to accommodate anticipated call volumes during peak congestion periods. Self-enforcement is usually used with other approaches, rather than as the only enforcement strategy. Communication with enforcement personnel is crucial to program effectiveness. It is important to note that citizen reports can provide valuable feedback to better assist enforcement efforts.

Enforcement of vehicle-occupancy requirements, use by authorized vehicles, or proper toll collection is critical to protecting eligible vehicles' travel-time savings and safety. Visible and effective enforcement promotes fairness and maintains the integrity of the managed lane facility to help gain acceptance among users and non-users.

Violation Rates

The violation data provided in Appendix A includes violation rates per 100,000 vehicles for the Katy, North, Gulf, Northwest, Southwest and Eastex freeways. HOV users and violators were counted on 15 minute intervals during the peak periods. The peak periods were determined to be from 6:00 to 9:30 a.m. and from 3:30 to 7:00 p.m. The counts were made on the following months: September 2007, December 2007, March 2008, June 2008, September 2008 and December 2008. The graphs in Appendix A show the percentage of violators for each of these months for the AM and PM periods. The graphs are based on the percentages calculated from adding together the HOV users and violators for each period, on each month's counts.

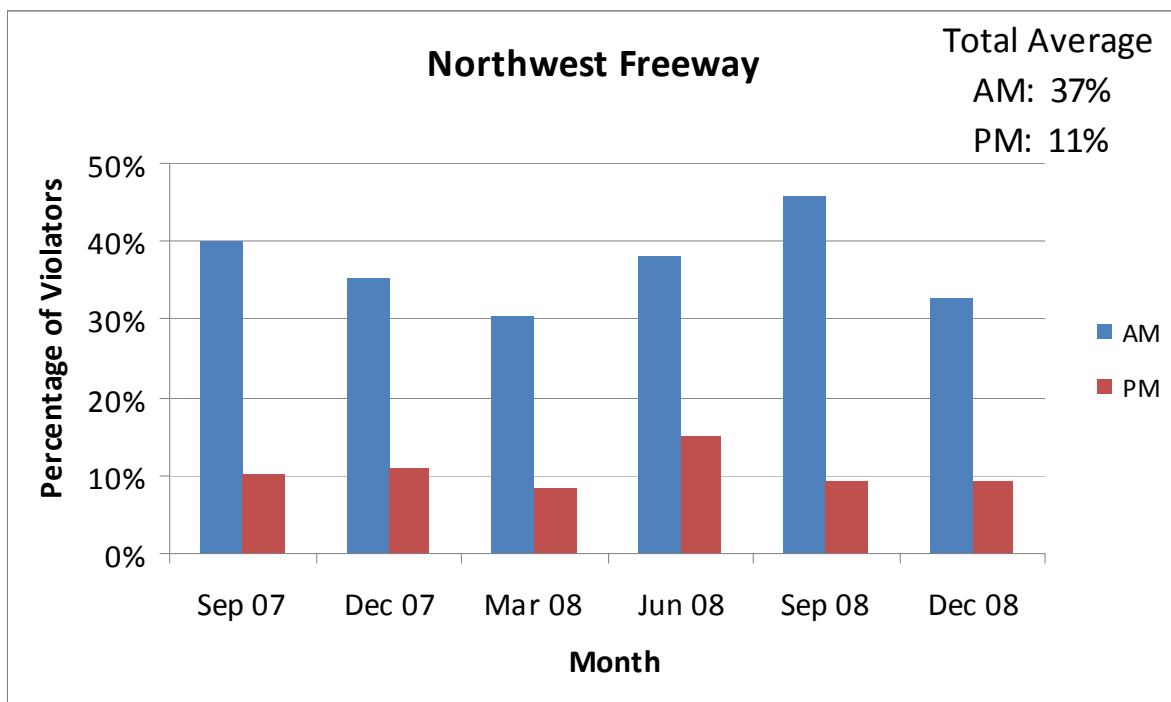


Figure 3. Monthly Violation Rates for the Northwest HOV Lane

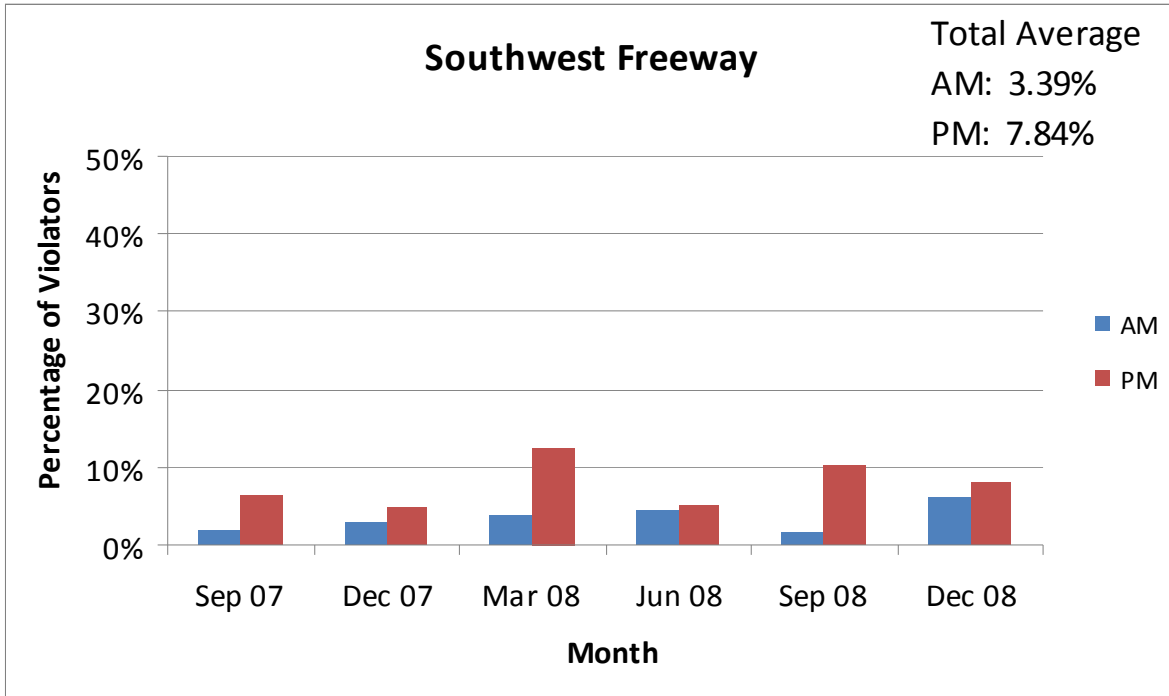


Figure 4. Monthly Violation Rates for the Southwest HOV Lane

For the Katy and NW freeways, data excluding QuickRide is also used. Violation rates for Katy and NW freeways were considerably higher than the other HOV lanes and they were generally higher in the morning than in the evening period. For the other freeways the violation rates ranged between 2 and 15 percent. Higher violation rates occurred when there was a 3+ restriction on the lanes due to registered QuickRide users who were not paying their tolls.

Survey of Operating HOT Lanes

The purpose of this research was to collect information on peer agency experience for High Occupancy Toll (HOT) lane enforcement efforts and cost recovery. Information was requested from the following HOT lane projects as of July 1, 2009:

- I-394 Express Lane Minneapolis, Minnesota
- I-25 Managed Lane San Diego, California
- SR 167 HOT Lane Pilot Project Seattle, Washington
- I-15 Express Lane Salt Lake City, Utah
- I-25 Express Lane Denver, Colorado
- I-95 Express Miami, Florida

Information was collected by sending a request for information to the appropriate enforcement contact for the lead agency for each HOT lane project. The request was in the form of an electronic message (email) with an attached document prepared in MS word. The document was 24 questions within two pre-formatted pages. A sample of the document is included as Appendix B. Each respondent could complete the information request by answering questions

and entering data directly into the document. Those agencies who did not respond to the email were contacted by telephone.

The following agencies provided responses to the HOT lane enforcement questionnaire:

- Minnesota Department of Transportation (MnDOT)
- San Diego Association of Governments (SANDAG)
- Washington Department of Transportation (WSDOT)
- Utah Department of Transportation (UDOT)
- Colorado Department of Transportation (CDOT)
- Florida Department of Highway Safety and Motor Vehicles (DHSMV)

Technical Memorandum 5 summarizes the results from the survey, which can be found in Appendix B. Information related to enforcement technology, methods, and violations rates were used in formulating the recommendations for this task.

Safety Data on Shoulder Reduction

Shoulders on a roadway are usually intended to accommodate stopped vehicles, for safety due to mechanical breakdown or other emergency stops. A scientific comparison of safety associated with shoulders is extremely difficult, due to the limitations in the data. Several factors related to road geometry, driver behavior, weather, distractions etc. influence the crashes in addition to presence or absence of shoulders. Finding comparable sites where difference in crashes is only due to influence of shoulders is difficult. Hence some indications from past research studies that have looked into the safety impacts of shoulders on highways are summarized, and a gross comparison of crash rates on selected freeway sections (with and without shoulders) in Houston are used to draw judgment in determining the safety impacts of using shoulders for enforcement on HOT lanes in Houston.

In general shoulders are perceived to improve safety by reducing implications of vehicles running off the roadway and for providing safe place for stopped vehicles. Several past research studies comparing the safety aspects of highways with shoulders and without shoulders indicates that having some shoulder does provide improved safety with respect to reduction in crashes. Provision of full shoulders on multilane suburban highways is shown to be associated with 10% lower accident rate as compared to roadways with just a curb and gutter. It is also shown that wider shoulders are associated with fewer run-off-the-road accidents (5).

Houston Crash Data Analysis

Crash data for a period of one year (2008) on selected freeway sections were extracted from the Crash Record Information System (CRIS) database. The selected roadway sections for comparison of crash data are:

No left shoulder (right shoulder present)

Site# 1. US 290 between IH 610 and SL 8 (7 mile section)

Site# 2. IH 45 between N Main St. and Little York St. (6 mile section)

With full shoulder

Site# 3. IH 45 between Gellispe St. and Parramatta St. (7 mile section)

Site# 4. US 290 between Senate Dr. and Telge Rd. (6 mile section)

The above study site locations are shown in Figure 5. All the site locations have the same speed limit. Sites 1 & 2 had no left shoulder but had a full 12 ft right shoulder. Sites 3 & 4 had full shoulders on both sides of the roadway.

The crashes obtained for the above mentioned sites consisted of all crashes for the freeway section (both directions), HOV lanes and the frontage roads. The data was sorted and only mainlane crashes were selected. The mainlane crashes include freeway (general purpose lane, GPL) crashes and HOV crashes, as these two are not differentiable from the crash database obtained. A plot of the mainlane crashes illustrates that the crash data at all the study locations are more or less uniformly distributed throughout the section. Closeup figures of the crash plot is presented in the Appendix C.

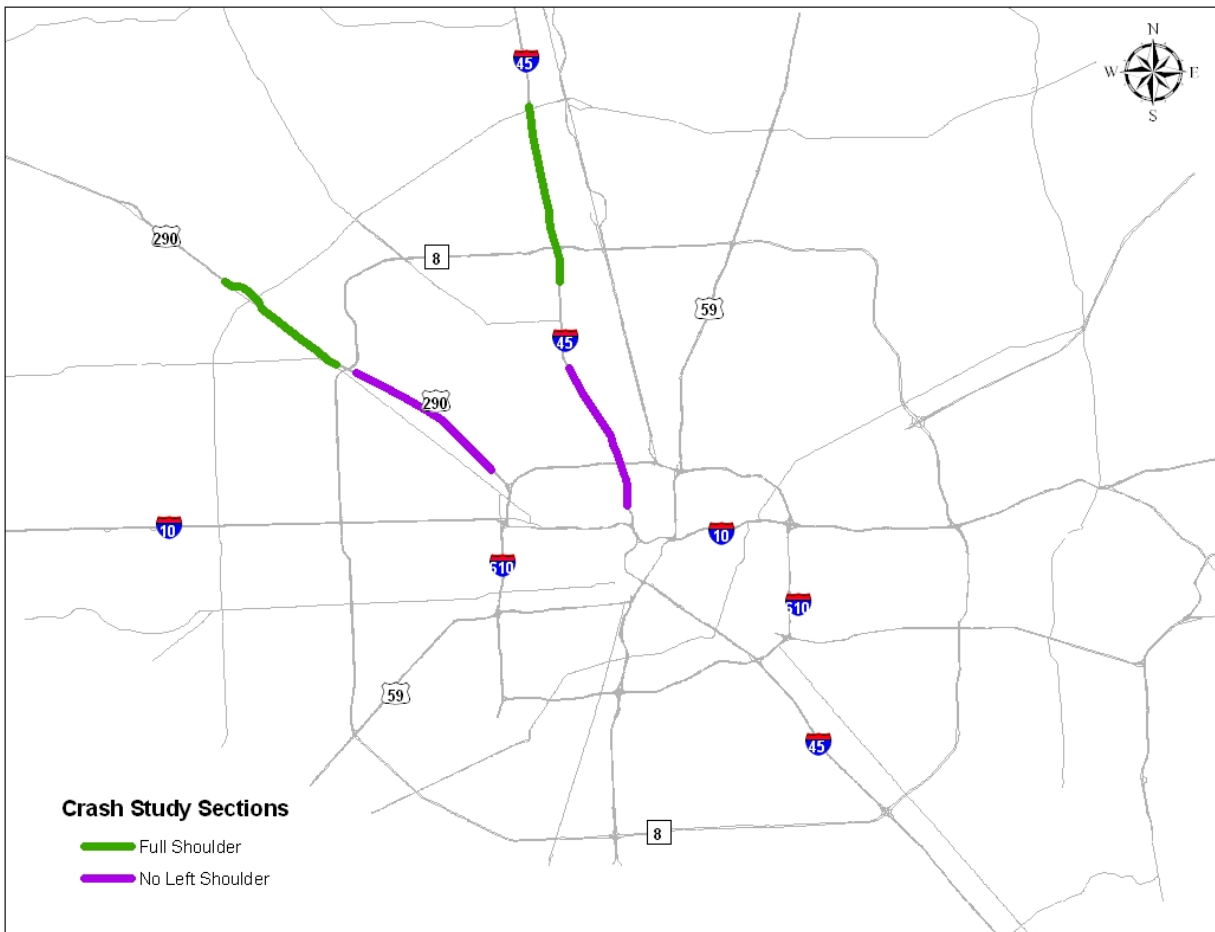


Figure 5. Location of crash study sections in Houston.

Crash rates were computed at the four study sections. As explained earlier in this section, obtaining crashes specifically related to shoulder width is difficult; hence an analysis of crash

rates are computed for different classification of crashes to see if any trend with respect to shoulder width could be observed. Table 1 presents the crash statistics for mainlane crashes, off road or shoulder related crashes and crashes involving fixed objects as the first harmful event. Crashes involving fixed objects were of interest as many of these crashes involved vehicles crashing (sideswipe) into shoulder barriers. All crash rates presented in Table 1 were computed for 100 million vehicles miles.

A comparison of the mainlane crashes on sites without the left shoulder (sites 1 & 2) and sites with full shoulder (sites 3 & 4) indicates an increased crash rate associated with sites that did not possess the left shoulder. Whereas crash rate computed for off-road and involving fixed objects crashes shows mixed results (no trend) between sites with and without shoulders.

Table 1. Comparison of Crash Rates at the Study Section

	US 290 (I-610 & BW 8)	IH-45 (N Main & Little York)	IH-45 (Gellispe & Parramatta)	US 290 (Senate & Telge)
Site #	1	2	3	4
Shoulder type	No left shoulder	No left shoulder	Full Shoulder	Full Shoulder
AADT (Mainlane, 2007)	207569	286758	248710	154902
No. of Lanes	7 - 10	7 - 11	7 - 11	6 - 8
Speed Limit	70	70	70	70
Total Crashes				
Mainlane (GPL + HOV)	238	431	240	111
Off road/Shoulder	22	52	53	15
Involving fixed objects	25	62	67	19
Crash Rate (per 100 million vehicle miles)				
Mainlane (GPL + HOV)	44.88	68.63	37.77	32.72
Off road/Shoulder	4.15	8.28	8.34	4.42
Involving fixed objects	4.71	9.87	10.54	5.60

In summary, crash rate analysis for mainlane crashes at specific Houston freeway locations and other safety research shows indications that no shoulder or insufficient shoulder width on freeway or high speed roadway facilities is detrimental to safety of the road users. However it should be noted that the current crash analysis and historical research compares sections with and without shoulders over at least a 1 mile section. HOT lane enforcement will likely result in smaller sections of shoulder being unavailable on the HOT lane, safety effects of which are not studied or captured in this or other research mentioned herein.

It is recommended that if shoulder on sections of HOT lane be taken for enforcement, the following precautions be taken (6):

- Shoulder enforcement should be on a flat section of the roadway with minimal vertical grade or horizontal curvature,
- Clear sight distance is available on the approach to the enforcement area, which provide good visibility for safety and efficiency;
- Sufficient lateral clearance is provided for the vehicles travelling in the lane adjacent to the shoulder,
- Good lighting and good visibility from a safe vantage point are needed to perform occupancy requirement enforcement,
- Enforcement areas for all types of HOV facilities should be designed not draw attention from motorist.
- Enforcement areas should have sufficient length and width to safely accommodate an enforcement and violator with adequate approach and departure tapers.

Automated Occupancy Verification

Discussion and recommendations regarding automated occupancy verification were developed based on FHWA's White Paper on occupancy enforcement technologies (7) and TTI's involvement in field testing activities at the national level.

SUMMARY OF FINDINGS

Enforcement Plans

To ensure efficiency, certain locations are more adequate for observation and enforcement. HOT lanes will continue to be barrier separated which allows the use of exit and entrance ramps as the common locations for observation. Based on AM and PM vehicle counts on each access/exit point, a recommendation will be done to locate efficient observation areas and enforcement points. By reducing the amount of spotting locations throughout the freeway, a more continuous flow is ensured at the same time fewer agents are needed.

Observation areas for the HOT lanes will be very similar throughout all the corridors considered. There will be two separate lanes for vehicles to declare at each target location. The HOV will go through the verification lane (closer to the booth) where an officer will confirm that the occupancy requirement is met. Vehicles that go through this lane will not be charged. The other lane will be for the SOVs, which will be charged by the electronic reading of their transponders.

The observation booth will need to be protected against crashes to ensure the officer's safety. It has to be located away from high speed lanes or any other location where personnel may be endangered.

A gantry will cover the two lanes. The gantry will have the necessary equipment to read and charge only the vehicles that go through the SOV lane. The observation areas will need to be equipped with good lighting, video surveillance, scanners and license plate recognition technology, to assist in verification and enforcement procedures.

The following section of the report details enforcement locations and considerations for each of the five corridors. The base case scenario presented is the current METRO plan for enforcement, and considerations for modifying problematic locations are articulated in the discussion. Corresponding schematics for each facility can be found in Appendix D.

I-45 North Freeway

Target Locations for Observation of Occupancy

The HOT lane for the I-45 North Freeway will extend north to south, from Parramatta Lane to Downtown Houston. The vehicle counts used to justify the target locations for this freeway were made on February 23, 2009.

Starting from the north, the first enforcement location would be just before Parramatta Lane. Vehicles entering through this slip ramp during the morning period will be identified and enforced at any of the possible exits.

FM 1960 exit and entrance ramps would be the next target location. There will only be a gantry at the entrance ramp and nothing on the exit ramp. Violators who enter at this point in the morning would be identified and stopped at any of the possible exits. For the evening period, violators should have been identified and stopped at previous locations.

The first observation area would be located at the Kuykendahl Park & Ride since the vehicle counts for the morning entrance and evening exit are considerably high. One single booth can be used to verify occupancy requirements by placing it in the middle of four lanes (expanded from two lanes, at certain location between the park & ride facility and the ramp to the freeway). To place the observation booth with four declaration lanes, the road would require modifications. Removing a portion of the sidewalk will definitely allow four lanes and a booth to be retrofitted. These lanes would be reversible to allow traffic flow both ways during the day. Violators entering or exiting will be enforced at this same location except for those entering the HOT lane during the morning; they would be identified and stopped at the exit they choose to use.

The two target locations that follow are the entrance and exit ramps for Aldine Bender Rd. and N. Shepherd/Veteran's Memorial Dr. which will not have observation booths. A gantry will be located at the AM entrance ramps to charge the motorists at their entry to the HOT lane. Morning exits and evening entries will not be allowed at these locations. Violators that enter at these points during the morning period would be identified and stopped at the exit location they choose

to use. Violators during the evening would have been identified and stopped in previous locations; therefore no observation or enforcement areas would be needed at these points.

The next target location for I-45 North Freeway will be the entrance/exit ramp at Airline Dr/Crosstimbers. This is a two way ramp, therefore entries and exits are allowed during both the AM and the PM periods. There is not enough space to locate four lanes and a booth at the bottom of the ramp for two directional observations. Closing the AM entry and the PM exit at this location could be a solution, but this should be done after analyzing the volume of vehicles that would be affected by the decision. The vehicle counts for this ramp show that the peak hour weekly average was 121 vehicles for the morning and 84 vehicles for the evening exit. Violators at this location would then be stopped either on the island enforcement area at the intersection with the HOT lane or on enforcement areas accommodated before and after the booth.

For the part of the HOT lane approaching downtown, observation areas will be placed one at each exit/entrance option: Quitman St., Katy Freeway, Smith/Louisiana streets and Travis/Milam streets. The possibility of combining the booths of the last two locations into one should be analyzed. Violators that entered during the morning period at previous locations would be identified and stopped at these exits. For the evening period, violators would be first identified at these booths and then stopped at the enforcement areas that would be provided. Almost all the observation and enforcement of the entire HOT lane would take place at these four possible exits/entries except for the one at Airline Dr.

Enforcement points

The first enforcement areas for the HOT lane in I-45 North Freeway, going southbound, would be at the entrance/exit ramp at the Kuykendahl Park & Ride. Violators would be stopped at this point either at the modified island located at the intersection with the freeway or at enforcement areas before and after the booth. The island will need to be modified to accommodate a minimum of two detained vehicles. It can be completely removed, leaving a striped area and/or pylons. The island could also be ramped, allowing agents to easily detain drivers without slowing down the traffic flow. The second option would be to accommodate enforcement areas before and after the booth. Available space could be a restriction for this last option but it should be considered as a safer option than the island modification. Enforcing next to a high speed lane should always be discouraged.

The island at the Airline Dr. location could function as another enforcement point. This is the minimum desired area and will need the same modifications mentioned for the Kuykendahl island. At the exit/entrance ramp, near the intersection to Airline Dr., there is also a potential enforcement point for AM or PM exits. It would not work for entries since the declaration area would come after that point, so another enforcement area should be considered before the booth, thus eliminating the island enforcing option. The enforcement areas before and after the booth are justified by the high vehicle count registered for the morning exits (295) and evening entries (379). These vehicles would exit the HOT lane unenforced if the areas are not accommodated at this location.

Close to the downtown area, the HOT lane splits into four final destinations. Between Quitman St. and Katy Freeway entrance/exit ramps there is an island that would function as an enforcement area after some modifications are made. This location would be used during the evening period to detain violators identified at the booths placed before this point. For the morning period, enforcement areas should be placed after the observation booths (in the morning direction of traffic). It is important to note that there is enough space to place these areas if appropriate modifications are made.

Enforcement for Smith/Louisiana and Travis/Milam morning exits would take place at the small pocket area located at the end of the lanes where the gates for the evening traffic are closed. For the evening period, enforcement would take place at the existing enforcement area located between the Airline Dr location and before the HOT lane splits to the two downtown ramps.

US-59 Eastex Freeway

Target Locations for Observation of Occupancy

The HOT lane for US-59 Eastex Freeway will extend from the Loop 494 wishbone ramp to Jackson/Chenevert streets in Downtown Houston. The vehicle counts used to justify the target locations for this freeway were made on February 9, 2009.

Entry gantries will be installed at the Loop 494 wishbone ramp, Townsen P&R, Will Clayton/McKay Av., Eastex P&R and the Tidwell Transit Center. No observation booths will be placed at these locations since the majority of the observation and enforcement will take place at the entrance/exit ramps nearest to downtown. It should be noted that the AM exit and PM entrance will be closed at Will Clayton, Eastex P&R and Tidwell Transit Center. The justification is that the vehicle count for these exits and entries are considerably low and that it simplifies the enforcement procedures. There are currently no AM exits and PM entries at Townsen P&R and SH 494 which also simplifies the enforcement procedures.

The first observation booth will be located at the exit/entrance ramp for Kelley St. Violators identified during the morning period will need to be stopped right after the booth. Violators entering at this ramp during the evening period would be detained at the enforcement area between this point and the Tidwell Transit Center to the north.

The next observation booth would be placed at the corner of the HOT lane with the entrance/exit ramp of Neches St (which is currently signalized as the Kelley St PM exit). This booth will take care of all traffic coming from downtown during the evening period and also all the traffic coming from the opposite side during the morning period. It will also have the purpose of identifying violators that try to exit at Neches St. Modifications will be needed at this location to accommodate two declaration lanes on the HOT lane which is currently one lane only. Violators identified at this booth during the morning period will be stopped at the enforcement point located at pocket area that remains when closing the Collingsworth/Quitman slip ramp for the AM period. Violators identified at this booth during the evening period would be detained at the enforcement area between the Kelley Street ramp and the Tidwell Transit Center. An extra enforcement area will also be located after this booth for violators trying to exit at Neches Street.

Finally, entry gantries with declaration lanes will be placed at the Collingsworth/Quitman slip ramp and at Chenevert Street. Modifications will be needed to accommodate the two declaration lanes and a gantry at each location. Violators that enter through here during the evening period will be identified when they arrive to the Neches St booth and will be enforced at the area between Kelley St and the Tidwell Transit Center.

Enforcement points

The first enforcement point will be located between the Tidwell Transit Center and the Kelley St. exit/entrance ramp, since the lane widens enough to permit a safe enforcement activity. The high vehicle count for the morning and evening periods also justify this location. This enforcement area will serve for the evening traffic coming from downtown Houston; violators identified at the Neches St. and at the Kelley St. observation booths will be stopped at this point.

Another enforcement point would be needed after the booth at the Kelley St. ramp. This area will allow officers to pull over violators that exit at this location during the morning period. Also, an enforcement point will be located for violators exiting at Neches St. during the evening period. At both locations there is enough space to do this.

The next enforcement point would be at the merging lane used during the PM period at the Collingsworth/Quitman slip ramp. Since this slip ramp is closed during the AM period, it could easily be used to pull over vehicles. The vehicles stopped at this point would have been identified at the combined observation booth of Neches St. exit/entrance. It is important to note that this enforcement point is before any possible exit other than the Kelley St. morning exit.

I-45 Gulf Freeway

Target Locations for Observation of Occupancy

The HOT lane for the I-45 Gulf Freeway will extend south to north, from the exit/entrance ramps south of the Sam Houston Tollway to Dowling Street at Downtown Houston. The vehicle counts used to justify the target locations for this freeway were made on February 23, 2009.

The first target location would be the exit/entrance ramps south of the Sam Houston Tollway, at the Dixie Farm Road terminus. A gantry would be placed at the entrance ramp to charge motorists at their entry to the lane. Vehicles that enter at this location during the AM period will be charged here but violators would be identified and enforced at any of the three possible exits: I-610, Eastwood Transit Center or Dowling St. An enforcement point would also be needed at the exit ramp of this location if an area is not accommodated after the observation booths at Dowling St, Eastwood Transit Center and I-610 for the PM period.

A very similar approach will be followed for the Fuqua P&R and the Southpoint P&R. Morning exits and evening entries are not allowed at these locations. A gantry would be placed to charge morning entries. No observation booths are planned. AM violators would be identified and stopped at any of the three possible exits mentioned before. Placing a PM enforcement area at

these locations will depend on the ability to locate adequate points at Dowling St, Eastwood Transit Center and I-610 (enforcement areas after the observation booths during the evening period).

The next target locations would be Monroe St (west) and Monroe P&R (east) exit/entrance ramps. It is important to mention that the plan includes closing the AM exits and the PM entries at these points. The justification for this is that the vehicle counts are considerably low for both procedures. As in the previous locations, there would only be a gantry for the morning entries. Observation and enforcement procedures for the AM period will take place on the three possible exits. On the other hand, for the PM period, observation will also take place at the entry points and enforcement will happen either at those locations or at specified areas at the end of these ramps.

At the entrance/exit ramps of I-610 there would be gantries on both sides. A side observation booth would be placed for the AM exit/PM entry ramp. For the morning period, an enforcement area would be needed after the booth since the vehicle count is high for this procedure (334). Although space is very restricted at this location, placing an enforcement area before the booth for the evening period would simplify the enforcement procedures for the entire corridor. Violators exiting during the AM period will need to be enforced at this point. Those entering during the AM period would be identified/stopped at one of the two possible exits remaining: Dowling St. or Eastwood Transit Center. Violators entering during the PM period could be identified at the side observation booth and stopped just after it or at an evening enforcement area located at the possible exits to the south. Those exiting during the PM period would need to be identified and enforced prior to this point since there is not enough space to place a booth or to pull over vehicles at this ramp.

The next target location would be the Eastwood Transit Center where existing operations do not allow AM entries or PM exits. A gantry with an observation booth between the two declaration lanes will be placed at the end of this exit/entrance ramp. Violators on the morning and evening periods would be identified and enforced at this location. Enforcement areas would need to be placed before and after the booth for this to happen.

The last observation booth would be placed at the exit/entrance at Dowling St. where there is an existing enforcement point that was commonly used for AM enforcement of the HOV lane. The conversion to HOT lane will require some modifications at this location. An observation booth should be accommodated with two declaration lanes, together with enforcement areas before and after it.

Enforcement points

At Dowling St there is an existing enforcement area but modifications are still needed. Two declaration lanes with a booth should fit, trying to accommodate pull over areas on each side. The morning period enforcement point would have priority, since it is indispensable at this location.

The next enforcement points would be located at the Eastwood Transit Center. Modifications at this location would include leveling of pavement and relocation of some trees. This would help to accommodate two declaration lanes, a booth, and enforcement areas for the AM and the PM periods.

Although there is a considerable restriction in space at the I-610 location, a side booth with two observation lanes will be located at the AM exit/PM entry ramp. At this same ramp, enforcement points should also fit before and after the booth.

The most efficient layout will be achieved if enforcement areas are accommodated before and after the observation booths at Dowling St., I-610, and at the Eastwood Transit Center. This would be the only way to avoid violators to go unenforced through the I-610 evening exit ramp. It would also eliminate the need of placing enforcement points at Monroe St., Monroe P&R, Fuqua P&R, Southpoint P&R and Dixie Farm Road ramps.

If this is not possible on one or more of the locations mentioned above, enforcement areas will then need to be accommodated for the evening period at Fuqua, Southpoint and Monroe P&R's as well as at Monroe St. and Dixie Farm Road ramps. It is important to note that enough space exists for this purpose at any of those locations.

US-59 Southwest Freeway

Target Locations for Observation of Occupancy

The HOT lane for the US-59 Southwest Freeway will extend east to west, from Alabama St. to the slip ramp at Wilcrest. The vehicle counts used to justify the target locations for this freeway were made on February 9, 2009.

Starting from the downtown area, the first target location would be immediately following the South Shepherd slip ramp. If some adjustments are made the HOV lane and shoulders may provide sufficient width to accommodate two declaration lanes and a booth. It is important to mention that the declaration lanes will possibly be narrow and might also require space taken from the general purpose lanes to retrofit.

Enforcement points should also be considered before and after this observation booth. This would help to identify and stop violators entering at Edloe St. during the AM period and violators entering at the Alabama St. slip ramp during the PM period. If this is not possible to accommodate, then violators entering at Edloe St. during the morning period (162) will go unenforced and violators entering at Alabama St. and South Shepherd St. during the evening period would need to be stopped in any of these possible exits: Westpark Dr., Hillcroft Transit Center, Westwood P&R, West Bellfort P&R or at West Airport Blvd. If these violators decide to exit through the Edloe St. ramp during the evening period, they would go unenforced if not stopped at the South Shepherd location. The vehicle count for this procedure is considerable (154) which justifies an enforcement area.

The next target location is Edloe St. where no booths are being considered due to the intersection's geometry and the restriction of space. However, there will be one gantry on each side with two declaration lanes each. Violators entering at this location during the PM period would not be identified until they arrive to their destination unless observation booths and enforcement points are provided for PM exits.

At the Westpark Dr. /I-610 ramp, there will be a combined observation booth for the exit and entrance lanes. The declaration lanes for the entry will not be next to the booth but the observer will have a direct line of sight; for the exit lanes the observer will be beside them. Violators identified will be stopped at this same location for both cases.

Another observation booth will be placed at Hillcroft Transit Center. It will allow identification of violators entering during AM and exiting during PM periods. Enforcement points will also be placed before and after the booth. Motorists that enter through this location during the evening period would be identified and enforced at the location they choose to exit. Motorists exiting during the morning period at this location would have been enforced at their point of entry.

The next target location would be Westwood P&R. An observation booth for the AM entries and PM exits will be provided. Regarding violators that enter during the morning period at Wilcrest or at West Bellfort P&R, they would already be identified at those locations and will be stopped either at that same point or at the enforcement area located at the end of the ramp of this P&R facility.

For the West Bellfort P&R facility a booth will also be placed for the AM entries and PM exits. Violators that are identified will be stopped at the enforcement area located just before/after the booth.

The last location to be analyzed is the slip ramp at Wilcrest. Some modifications will need to be made to accommodate two declaration lanes and a booth for observation. In addition, for enforcement efficiency, space should also be considered to accommodate detained vehicles. This location is important since it is the beginning of the HOT lane for the morning period. Every vehicle identified as a violator during the PM period would need to be stopped immediately after the booth; if this is not possible, vehicles that entered at Edloe St. would go unenforced through this point. During the morning period, if violators are detained at this location, then no enforcement areas would be needed for those exiting at Westwood P&R, West Bellfort P&R or at Hillcroft Transit Center. If this cannot be accomplished, then every possible exit will need to have enforcement areas and violators will be able to exit at Edloe St. without being stopped. The officers will also need to have an efficient way of communicating with the observers at the other locations and be able of re-identifying the vehicle.

Enforcement points

The first enforcement areas starting from downtown Houston are those before and after the booth at the South Shepherd slip ramp. The lane appears to be wide enough to allow enforcement. During the morning period it will mainly serve to detain vehicles that entered at Edloe St. For the evening period, it will prevent violators from exiting at Edloe St. without being enforced.

The next enforcement point would be at the end of the exit/entrance ramp at Westpark Dr. The area will need to be modified to accommodate two or more detained vehicles, the island will need to be ramped up and adequately marked. It is important to note that congestion has been constant at this point during the AM period. Therefore, the enforcement area should be large enough to avoid an increase of the problem. Also, modification of the signalized intersection should also be considered to allow a more constant flow at this exit of the HOT lane.

At the Hillcroft Transit Center, Westwood P&R and West Bellfort P&R, enforcement points would be located before and after the observation booths for the morning entries and evening exits. This will prevent motorists from skipping traffic by going from one park and ride facility to another. Another enforcement point might be needed for the morning exits if it is not possible to accommodate an area for the morning period at Wilcrest.

The last enforcement areas would be located before/after the observation booth at West Airport. Violators that enter through Wilcrest during the morning period would be identified and stopped at this location. If it is not possible to accommodate an enforcement area as specified, then violators would need to be stopped at one of these exits: West Bellfort, Westwood or Hillcroft. If these violators decide to exit through Edloe St. then they would go unenforced. If an enforcement area is not accommodated at South Shepherd, they would also go unenforced on the exits further north. The officers will need to have an efficient way of communicating with the observers at the other locations and be able of re-identifying the vehicle as previously stated.

The enforcement points for the US-59 Southwest Freeway were kept some distance from the T-ramps due to the narrow geometry of the islands and the safety implications this represents for officials and motorists. Also, at this specific freeway, there is enough space at the end of each exit/entrance ramp to place these areas. This makes enforcement activities safer by preventing officials from standing next to a high speed lane.

US-290 Northwest Freeway

Target Locations for Observation of Occupancy

The HOT lane for the US-290 Northwest Freeway will extend from the slip ramp at N. Eldridge Pkwy to the Northwest Transit Center. The vehicle counts used to justify the target locations for this freeway were made on February 23, 2009.

The first target location would be the beginning of the current HOV lane at the N. Eldridge Pkwy slip ramp. Some adjustments will need to be made to fit two declaration lanes and a gantry. Violators entering at this point during the AM period will be identified and enforced at any of the possible exits throughout the freeway.

The Northwest Station ramp would be the next target location. This location does not allow AM exits or PM entries. A gantry with two declaration lanes will be needed if motorists are going to be charged a distance based fee. If not, they can easily be charged at the end of their trip during the morning period and at the beginning of it during the evening.

West Little York P&R would be the next entrance/exit ramp to consider. It is important to note that exits and entries are permitted for both AM and PM periods. Therefore, the facility will need important modifications to accommodate two lanes, one gantry and one observation booth specifically for the morning exit and evening entrance, plus enforcement areas. Violators that enter during the AM period through N. Eldridge slip ramp or the Northwest Station ramp, will be identified and stopped if they exit through this location. Violators who enter at this point during the morning would be identified and stopped at any of the possible exits, not at this location. For the evening period, violators would be identified and enforced at the location they entered.

The next target location would be Pinemont Dr. exit/entrance ramp. Exit and entrance is permitted during morning and evening periods also. Modifications will be needed to accommodate observation areas and enforcement points for vehicles exiting the HOT lane during the morning and entering during the evening. A gantry will be needed for the AM entry if motorists are going to be charged a distance based fee. Violators entering during the morning at the beginning of the lane, at Northwest Station or at W. Little York P&R will be identified and enforced if they exit at this location. Motorists entering at this location during the AM period will be identified and enforced either at Dacoma St. or at the Northwest Transit Center. During the evening, violators that exit at this location would have been enforced at the point where they entered the HOT lane.

Dacoma St.'s wishbone ramp would be the next location. Two declaration lanes and an observation booth will be placed at each ramp. Space is limited at these points but with some modifications, there should be enough area to stop identified violators. Violators that entered during the morning period through any of the previous locations would be identified and enforced if they choose to exit through this ramp. Placing a booth and an enforcement point at this location is justified by the average peak hour vehicle count of 392 for the morning period. This same observation booth at the exit ramp will also identify violators that try to skip traffic during the morning period by entering at the NW Transit Center and exiting at this location, using the two way ramp between both. Violators entering at this location during the AM period will be identified and enforced at the NW Transit Center. Those violators that enter during the PM period need to be identified and enforced at this location. If not, they would go unenforced through any of the possible exits.

The last target location is the Northwest Transit Center. Modifications will be needed to place one observation booth for the entrance and one for the exit declaration lanes (two lanes each). During the morning period, violators that entered at any other location would be identified and enforced at this point. There will be no need to enforce the AM entry since these vehicles will forcefully exit at Dacoma St. where they would be enforced. During the evening period, violators should be identified and enforced at this location, if not, they would exit unenforced at any point. The vehicle count for the evening entries at this point is considerably high (935) which justifies placing the observation booth and enforcement area. There will be no need to have observation and enforcement for vehicles exiting at this location during the PM period since they would have been stopped at the entrance ramp of Dacoma St.

Enforcement points

The first enforcement point would be located at W. Little York P&R for violators identified during the AM exit and PM entrance. It is important to note that they will be two different areas and that they would need to be located before and after the observation booth. Some modifications will need to be done to accommodate the enforcement areas, including the relocation of some trees. They will need to be large enough to detain a minimum of two vehicles. It should also be consider that placing a police officer during the evening entry represents informing possible violators that enforcement is taking place. They would then have sufficient time to avoid entering the HOT lane.

A similar approach would be followed at the Pinemont Dr. exit/entrance. The enforcement areas will be located before and after the observation booth to allow stopping vehicles that exit the HOT lane during the morning period and enter during the evening period.

Enforcement areas at Dacoma St. would be located at the bottom of the ramps, after the observation booths (following the direction of traffic). It is important to note that modifications will be needed on both ramps to accommodate the declaration lanes plus the enforcement areas.

The last enforcement areas would be located at the NW Transit Center. The lanes will need to be re-arranged to accommodate the declaration zones and the enforcement areas.

Safety Issues

(Rob Benz to provide)

ENFORCEMENT STRATEGIES - RECOMMENDATIONS

Observation of Vehicle Occupancy

- The proposed enforcement concept for the Houston HOT lanes (i.e., declaration lanes with observation booths) provides an opportunity to target enforcement at those who self declare as an HOV, narrowing the set of vehicles that must be observed. This is an advantage over many conversion projects that require officers to either observe all vehicles or use some form of technological strategy (like beacon or patrol car-mounted tag reader).
- The observation booths are proposed to be equipped one-way glass to prevent drivers from knowing in advance if there is an officer in it. A random scheduling of observation and enforcement reduces violation rates by preventing users from knowing the times at which enforcement takes place.
- Observation areas need to have good lighting and good visibility from a safe vantage point to assist in the visual verification procedure.

- Observation booths should be situated alongside or slightly downstream from the “HOV-only” lanes so as to provide optimum interior views of vehicles. If the observation location is to be separate from the apprehension area, further improvements such as a raised platform for better viewing angle can be employed.
- Visual confirmation of occupancy will be more accurate under low-speed conditions, therefore entry and exit ramps are the target locations.
- Enforcement areas should provide adequate space to accommodate the patrol and the detained vehicle in a safe environment. The officer needs to be able to stop the violator to issue a citation in a safe enforcement area.
- Surveillance and apprehension at entrances or exits is the most efficient way of enforcement at barrier separated facilities. The geometric requirements for a reversible facility like Houston’s HOT lanes provide enforcement pockets within the slip ramps that can serve as enforcement areas for the opposing direction.
- To avoid reductions in HOT lane traffic speeds and unnecessary congestion, enforcement personnel should make use of non intrusive techniques. Officers should not: partially block the lane while observing or apprehending violators; leave emergency lighting on, causing driver distraction; stand outside their vehicles near the lane; have more than one car waiting to be ticketed; and have multiple patrol vehicles at one location.
- Officers parked in enforcement areas waiting for violators need to be communicated with the observation point and have a way to re-identify a violator. It is important to note that a mobile enforcement reader is favored by officers because it can provide them with positive confirmation of toll transactions.
- If a self enforcement program will be used for the Houston’s HOT lanes it is important to note that the tracking of repeat violators is a key feature contributing to the success of the program. Users prefer reporting systems handled by live operators than automated systems; therefore, staffing resources should be able to accommodate anticipated call volumes during peak congestion periods. Avoiding lose of credibility on the warning notices sent to violators is also crucial to an effective self enforcement program.

Operation

- A monitoring program is recommended to determine compliance levels, provide a basis for fine-tuning enforcement operations, and identify problems that may need to be addressed. Performance monitoring programs provide the ability to determine if the goals and objectives of an enforcement program are being achieved. Evaluations may also be needed to meet federal or state requirements.
- One out of six HOT lanes included in the research sets a violation rate goal and threshold for reevaluation of enforcement. These types of measures are considered helpful to maintain low violation rates.

Public Awareness and Education

- A continuous public awareness campaign is recommended to aid enforcement. If the public is made to understand the HOV operating strategy and its restrictions, the tendency to violate may be reduced. Furthermore, enforcement agencies uniformly concur that a public awareness program that notifies the public of enforcement activities helps to increase the effectiveness of the enforcement effort.
- The primary message that should be transmitted with respect to HOT enforcement education should be a simple statement of what the law states and what is prohibited, what will be done if a violation of that law occurs, and what the consequences are if a violator is apprehended or cited.
- Information should be provided on an ongoing basis through signing along the facility, as well as in marketing brochures and materials. This information will also keep non-users with a positive perception that the requirements are being enforced and that the integrity of the facility is being maintained.
- Accurate signs explaining the operational procedures of HOT lane facilities, such as toll information, are also important for safety and enforcement. Informed drivers are less likely to commit unsafe last-minute maneuvers or inadvertently violate the HOT lane.
- A major focus of media relations should be on soliciting the media for help. Press releases and press conferences, editorial board and assignment editor briefings, and media tours can all be used to heighten awareness and increase visibility of the enforcement program. By making enforcement visible, violation rates are more likely to be low.

Legal and Judicial Issues

- A good enforcement program can be undermined by the judicial branch of government if the judicial branch does not uphold the citations issued by the enforcement agency. It is unknown at this time how METRO intends to structure the violation enforcement process, but treating violations as a civil offense rather than a criminal/moving violation will offer greater flexibility and retention of revenues. Decriminalization of HOV violations should be considered to ease prosecutorial evidentiary burdens and facilitate adjudication.
- Uniform state rules for penalties should be enacted to reduce inconsistent judicial fine assessments, and to facilitate awareness of fine amounts. It is recommended to set the fine amounts to levels that constitute a credible deterrent to potential violators.
- An escalating fine structure for repeat offenders is recommended. A multi-year period for the tracking of repeat offenders should be encouraged to maximize effectiveness of an escalating fine structure.

- Legislation requiring the display of toll transponders or other readily visible identifier should be considered. The difficulty in proving toll violations on HOT facilities can be ameliorated by legislation pertaining to the display of transponders.
- Additional legislative language to expand the definition of prima facie evidence for HOT violations may become helpful if viable technologies for automated enforcement emerge.
- It is important to ensure that current state policies and guidelines clearly articulate the types of law enforcement and emergency vehicles that can use a HOT lane without meeting the occupancy requirements. The policies and guidelines should be clearly communicated to the agencies responsible for law enforcement and emergency services, policy makers, and the public.
- Existing fines should be reviewed, and if necessary updated, for the HOT lane implementation. Penalties for violations must be adequate to discourage the willful violator such that reliance on dedicated enforcement officers can be minimized.
- It was found in the research associated with other HOT projects that in some cases there is no penalty for non-payment of the fines. An effort should be done to prosecute these violators to maintain an efficient enforcement system.

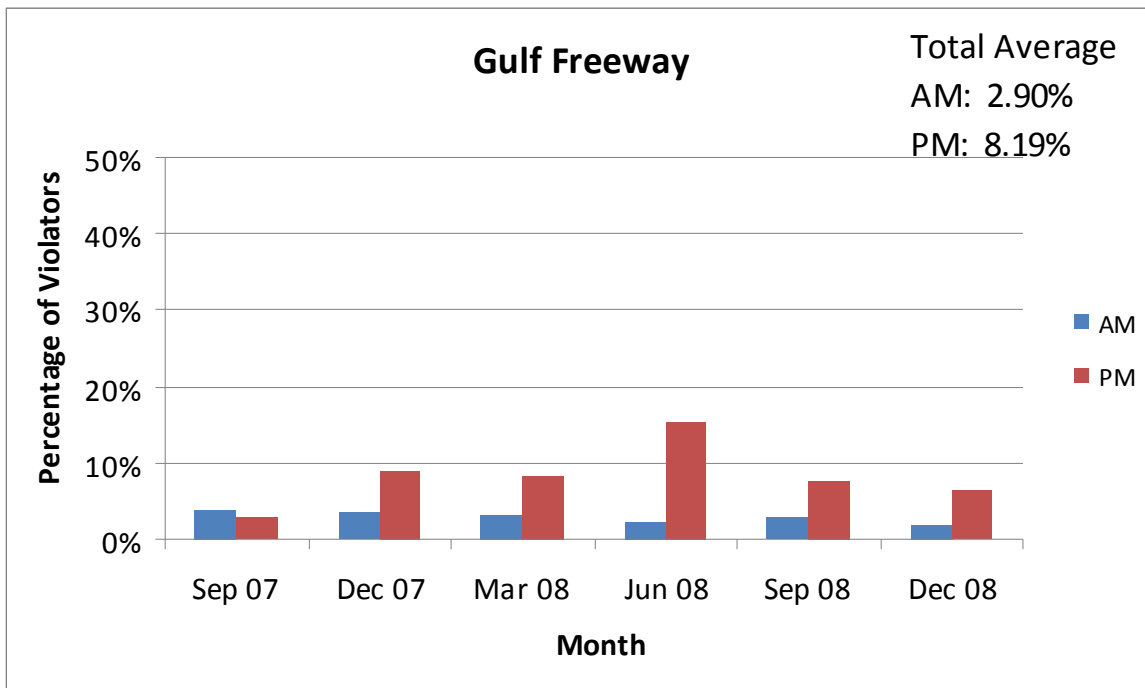
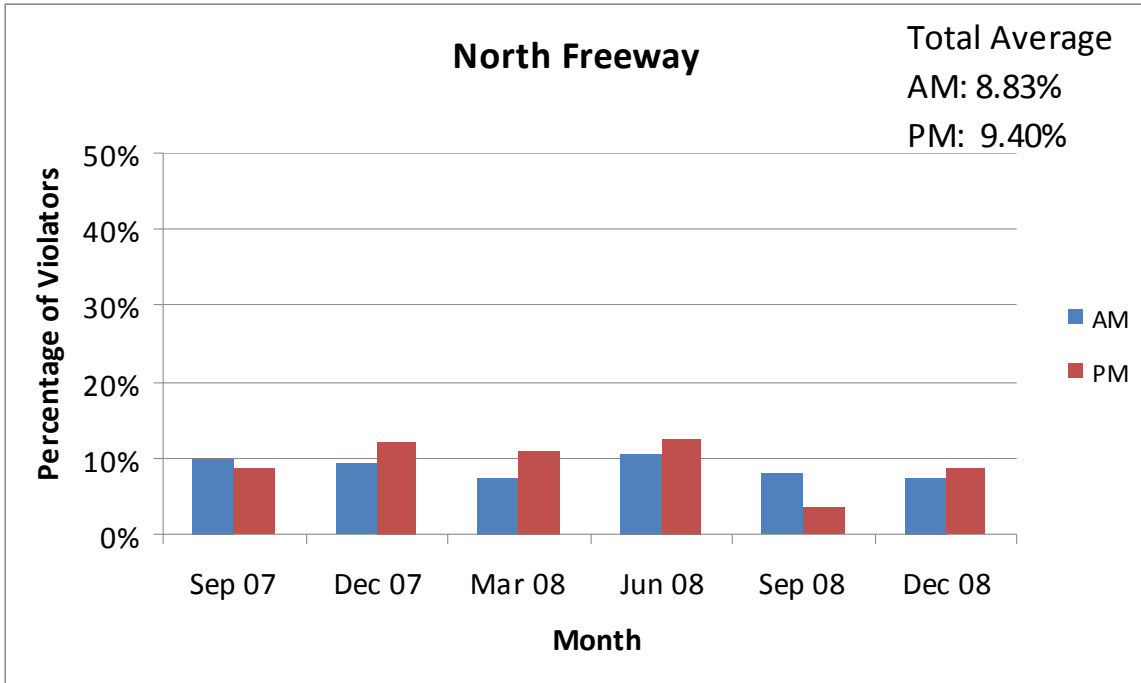
Automated Enforcement of Occupancy

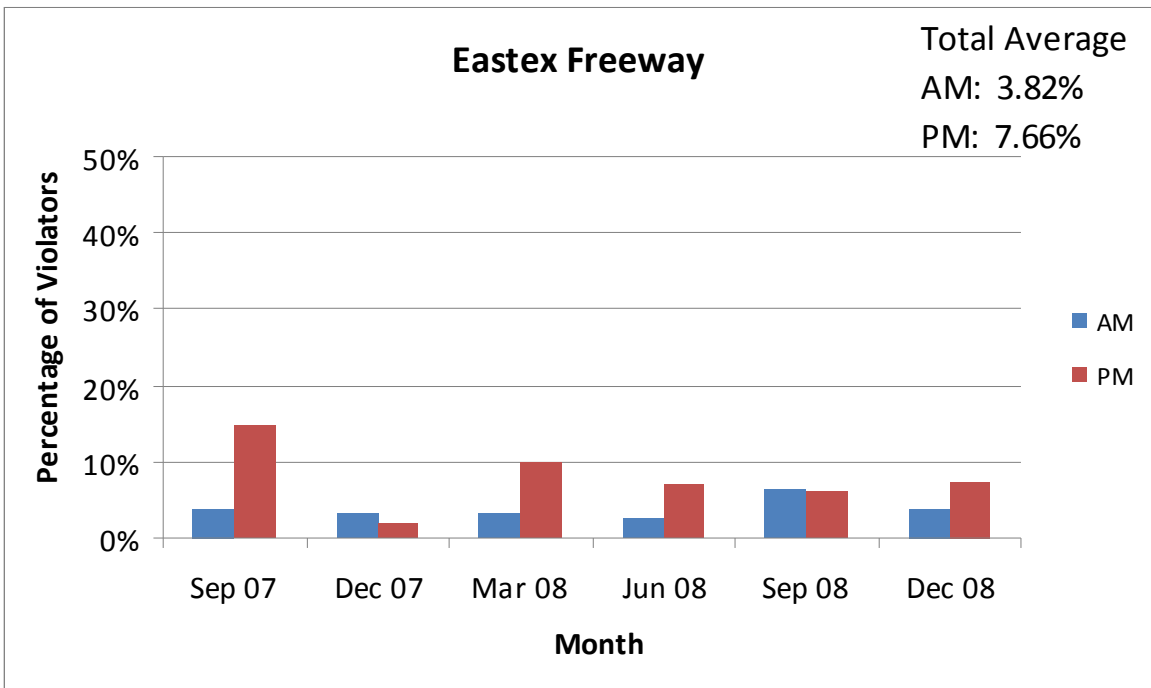
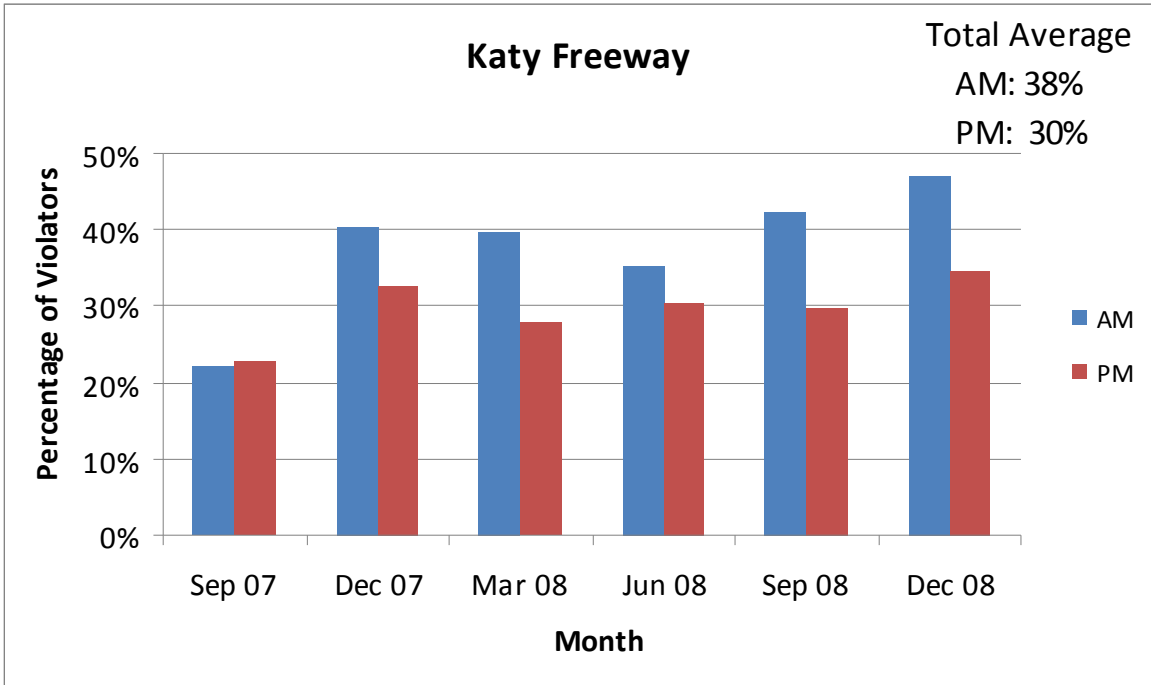
- There is currently no commercially-available technology with proven effectiveness in accurately and reliably counting the number of people inside a vehicle.
- Two projects will likely be conducting field testing in 2010 (San Diego I-15 and Northern Virginia I-495) of a multi-band infrared imaging system that can detect occupancy. TxDOT and METRO should monitor the ongoing activities in this area and assess the potential for future deployment on the Houston HOT lanes if the system proves effective.
- Future use of any such technology as an automated enforcement mechanism will require legislative changes. In the interim, multi-band infrared or any other technology may be used as a tool to further target enforcement activities on likely violators, adding to the reduction in target observations and detainments offered by the proposed use of declaration lanes.

REFERENCES

1. J. Wikander, V. Goodin. *HOV Lane Enforcement Handbook*. Report for the HOV Pooled Fund Study. Federal Highway Administration. March 2006.
http://hovpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=49&new=0 (last accessed July 31, 2009)
2. METRO HOT Lanes Presentation.
http://metrosolutions.org/posted/1068/METRO_HOT_Lanes_Final_Rev4_071108_english.217687.pdf (last accessed July 31, 2009)
3. Current HOV Guide Houston <http://www.ridemetro.org/SchedulesMaps/HOV.aspx> (last accessed July 31, 2009)
4. METRO Concept of Operations for Conversion of HOV Lanes to HOT Lanes. April 2007.
5. E Hauer. Shoulder Width, Shoulder Paving and Safety. Unpublished Report
<http://www.roadsafetyresearch.com> (accessed July 27, 2009)
6. *Guide for High-Occupancy Vehicle (HOV) Facilities*. American Association of State Highway and Transportation Officials, Washington, DC, October 2004.
7. V. Goodin, J. Wikander, et.al. *Automated Vehicle Occupancy Verification Technologies*. White Paper for the HOV Pooled Fund Study. Federal Highway Administration. Report FHWA-HOP-07-132. August 2007.
http://hovpfs.ops.fhwa.dot.gov/cfprojects/new_detail.cfm?id=61&new=0 (last accessed July 31, 2009)

APPENDIX A: VIOLATION DATA





APPENDIX B: SAMPLE QUESTIONNAIRE

HOT Lane Project (Name and Facility): _____

Information Provided by:

Name: _____

Email: _____

Phone: _____

1. Are you.....
 _____ part of the HOT lane organization
 _____ hired from sheriff office/ city police
2. How many lane miles of HOT lanes do you enforce? _____
3. What categories of violations do you enforce?
 _____ Occupancy
 _____ Buffer violation
 _____ Speeding
 _____ Other: _____
4. Who enforces HOT lane violations? _____
5. What type of technology are you using to assist with...
 toll evasion? _____
 occupancy violation? _____
6. What is your annual cost for enforcement? _____
7. What is the funding source for enforcement costs? _____
8. What is included in this cost?
 _____ Law enforcement officers
 _____ Vehicle occupancy observers
 _____ Patrol vehicles – cruiser
 _____ Patrol vehicles – motorcycle
 _____ O&M for enforcement technology
 _____ Other: _____
9. Describe your level of enforcement coverage
 Number of officers _____
 Number of observers _____
 Hours of field enforcement per officer _____ weekly/monthly
10. Which time periods do you enforce?
 _____ Peak periods only
 _____ All day
11. What type of enforcement areas do you have available?

- _____Wide shoulders throughout, width: _____
- _____Intermittent enforcement – pullout areas
- _____None – roving patrols only

12. In your professional opinion, is what you have adequate? _____

13. How do you enforce HOT lane violations?

- _____Pre-existing HOV laws (moving violation)
- _____Assess an administrative penalty for toll evasion
- _____A combination: _____

14. For moving violations, what is the fine? _____

15. Do you have a penalty system such as escalating fines or points on driver's license?

If so, please describe. _____

16. For moving violation fines, where does the fine revenue go? _____

17. Is any fine revenue used for HOT lane enforcement? _____

18. What is the administrative penalty for toll evasion, in addition to the toll? _____

19. What is the penalty for non-payment? _____

20. Does law enforcement assist with repeat violators? _____

21. Are there any penalties for non-payment, such as withholding vehicle registration?

22. What is your violation rate? _____

23. Do you have established violation rate goals? _____

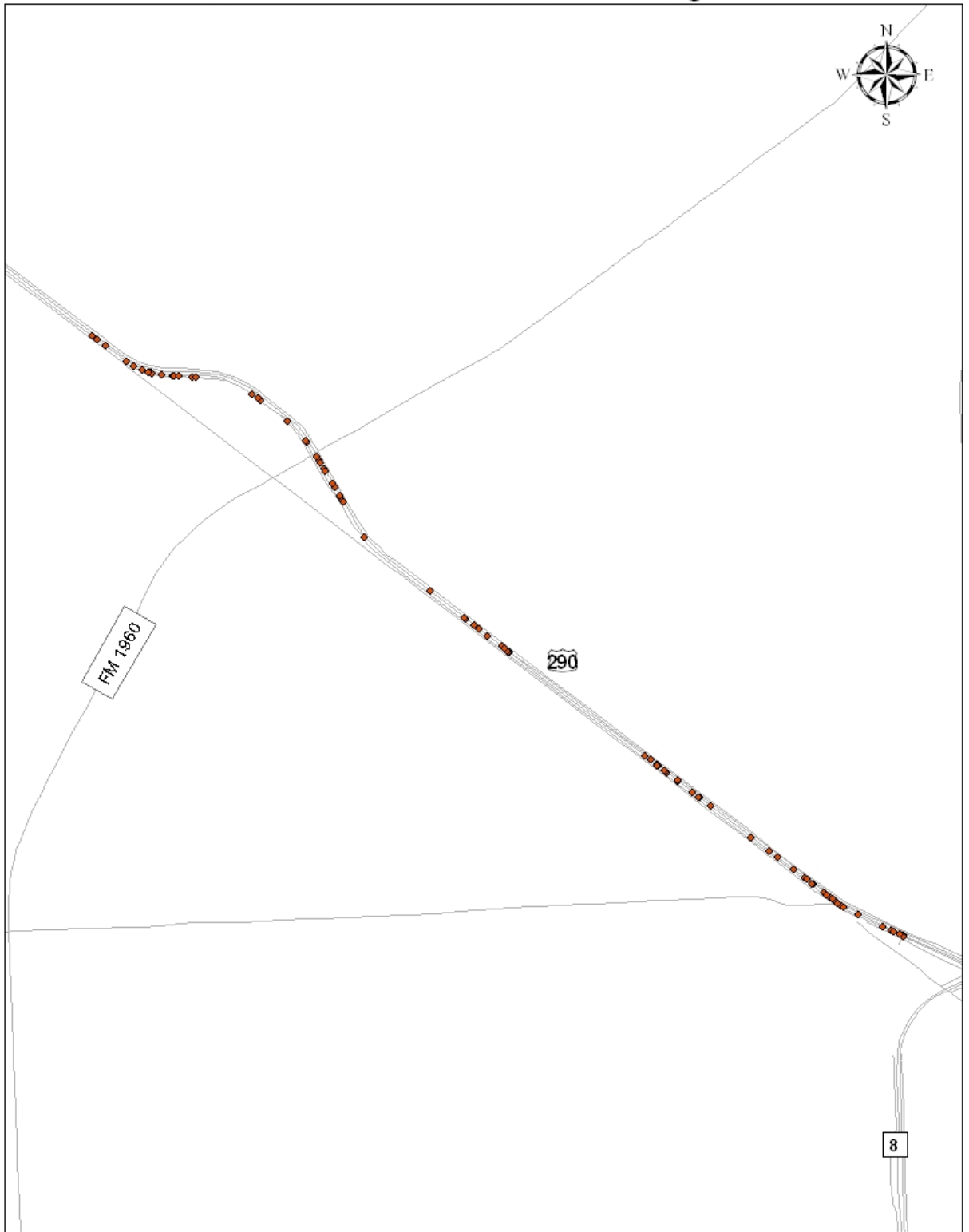
If so, what are goals? _____

24. Do you have a violation rate threshold that triggers a reevaluation of enforcement strategies? _____

If so, what is your threshold? _____

APPENDIX C: CRASH DATA PLOTS

US 290 Between Senate Dr. and Telge Rd.




APPENDIX D: HOV FACILITY SCHEMATICS

Houston HOT Enforcement Areas

Legend:

Blue – Enforcement equipment

 – Gantry

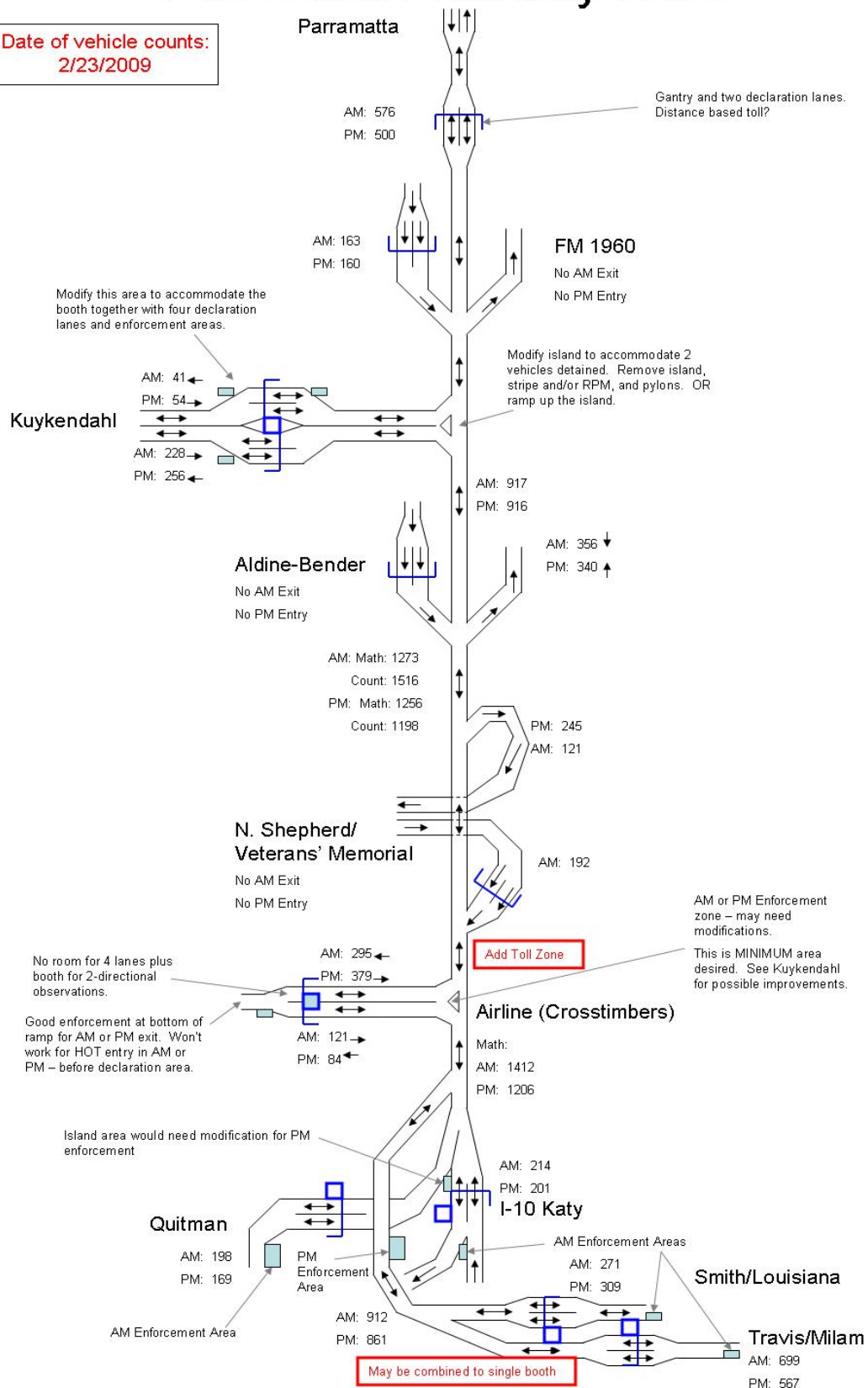
 – Booth

 – Enforcement areas

Black – the lanes and their directions

I-45 North Freeway HOV

Date of vehicle counts:
2/23/2009

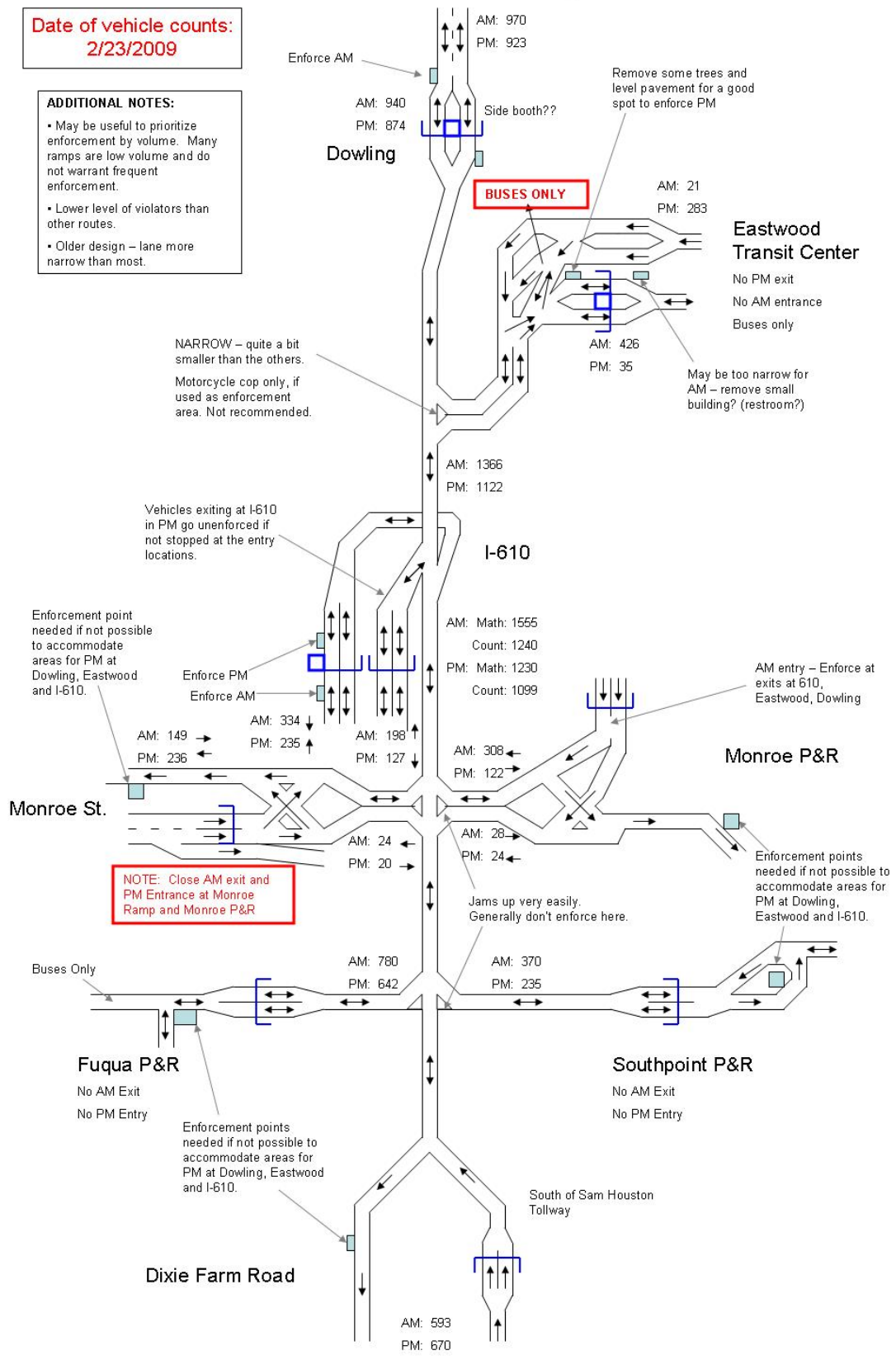


I-45 Gulf Freeway HOV

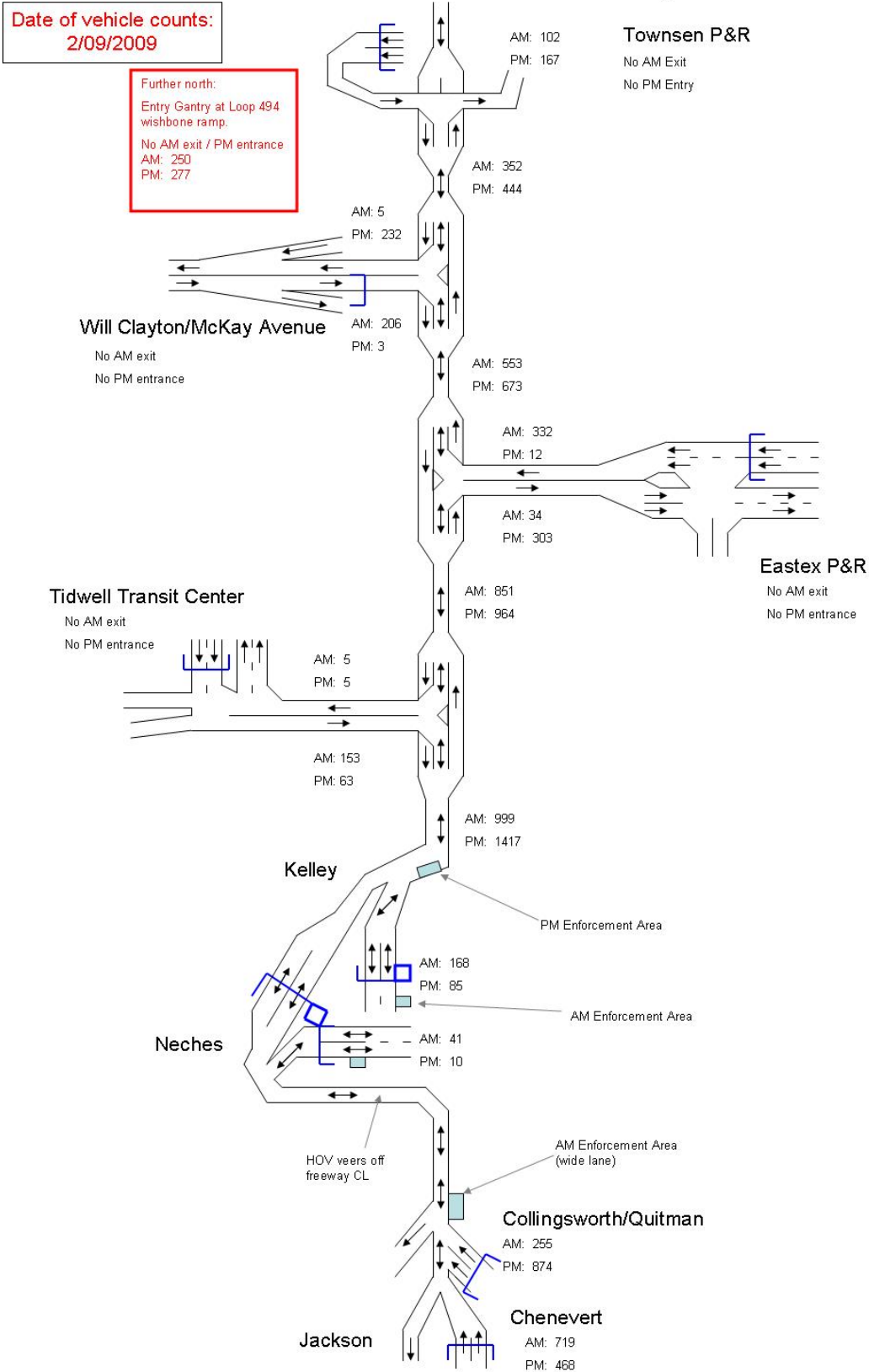
Date of vehicle counts:
2/23/2009

ADDITIONAL NOTES:

- May be useful to prioritize enforcement by volume. Many ramps are low volume and do not warrant frequent enforcement.
- Lower level of violators than other routes.
- Older design – lane more narrow than most.



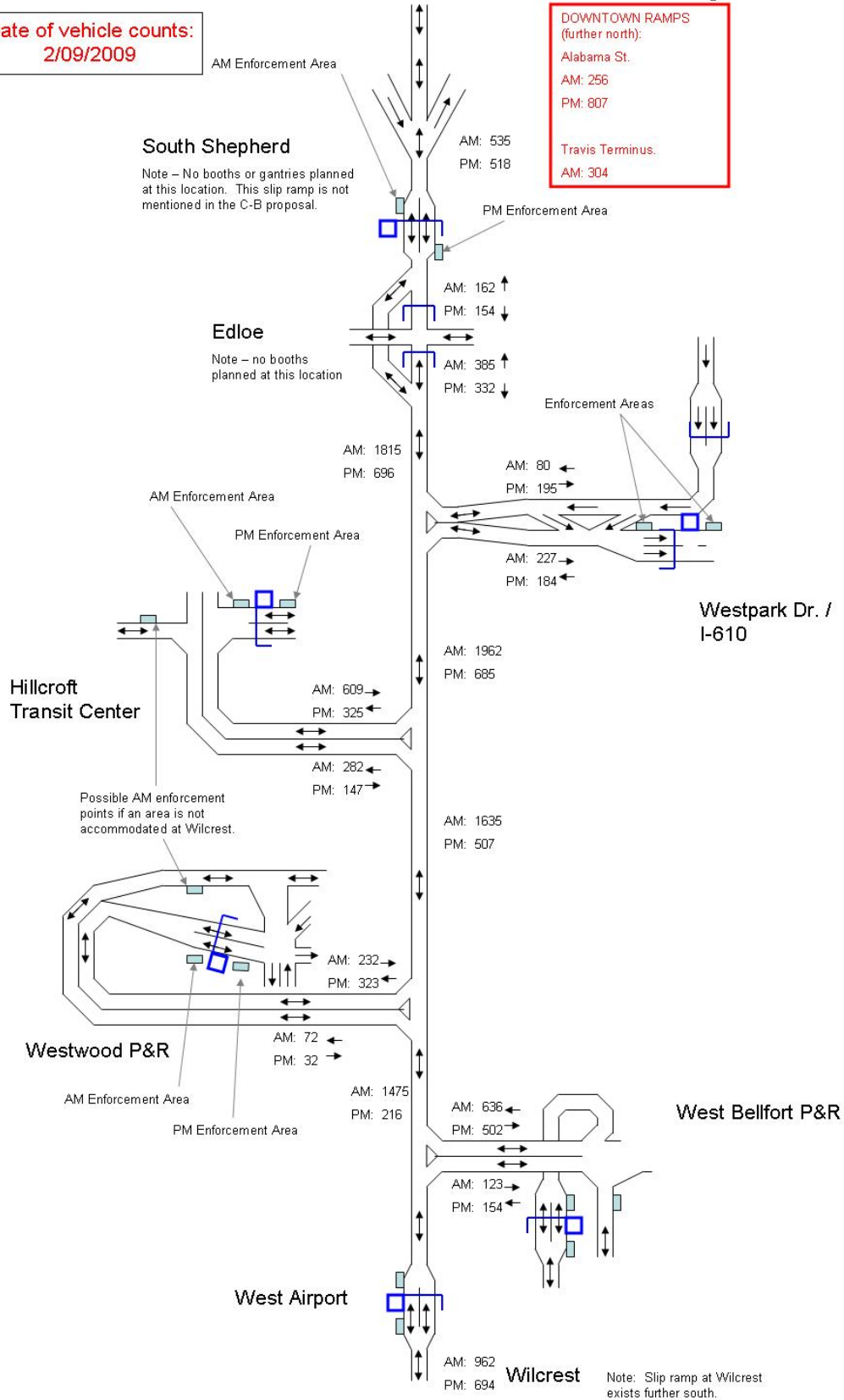
US-59 Eastex Freeway HOV



US-59 Southwest Freeway

Date of vehicle counts:
2/09/2009

DOWNTOWN RAMPS
(further north):
Alabama St.
AM: 256
PM: 807
Travis Terminus.
AM: 304



US-290 Northwest Freeway

Date of vehicle counts:
2/23/2009

