COMMONWEALTH of VIRGINIA

DEPARTMENT OF ENVIRONMENTAL QUALITY
Street address: 629 East Main Street, Richmond, Virginia 23219
Mailing address: P.O. Box 1105, Richmond, Virginia 23218
Fax (804) 698-4500 TDD (804) 698-4021
www.deq.virginia.gov

L. Preston Bryant, Jr.
Secretary of Natural Resources

David K. Paylor
Director

(804) 698-4000
1-800-592-5482

To: The Honorable Timothy M. Kaine

Members of the General Assembly

From: David K. Paylor

Date: January 1, 2008

Subject: On-Road Emissions Testing Program Status Report

I am pleased to provide you with a copy of the Department of Environmental Quality's (DEQ's) "On-Road Emissions Testing Program Status" report. This report has been prepared pursuant to House Joint Resolution 208 (2006) and provides an update regarding the on-road emissions testing program.

The on-road emissions testing program has provided valuable information regarding fleet emissions in northern Virginia and data from the program indicate that the biennial emissions inspection program in Northern Virginia has been successful in reducing vehicle emissions.

This report is being made available at www.deq.virginia.gov/regulations/reports/html. If you have any questions concerning this report or if you would like a hard copy of this report, please contact Angela Jenkins, Assistant Director of Legislative and Legal Affairs at (804) 698-4268.

ON-ROAD EMISSIONS TESTING PROGRAM STATUS

A Report to the Honorable Timothy M. Kaine, Governor and the Virginia General Assembly

Virginia Department of Environmental Quality

January 2008

EXECUTIVE SUMMARY

This report is being provided to the General Assembly pursuant to House Joint Resolution 208 (2006) and provides an update of the on-road emissions testing program.

INTRODUCTION

In 2006, the General Assembly issued House Joint Resolution 208 which requested that the Department of Environmental Quality (DEQ) consult with the United States Environmental Protection Agency (EPA) to identify and implement ways to increase the use of on-road remote sensing of vehicle emissions. The resolution further requested that DEQ, in consultation with EPA, identify gross polluters and increase the percentage of vehicles that may be prescreened using on-road remote sensing of vehicle emissions in the Northern Virginia nonattainment area and provide information on associated costs and air quality benefits and impacts. The resolution directs DEQ to report its progress to the 2007 and 2008 General Assemblies.

In August 2006, DEQ implemented the On-Road Emission (ORE)[1] high emitter identification program and since then has notified 218 vehicle owners that their vehicles were observed as having emissions above specified standards and requested that the vehicles undergo a verification emissions test and make necessary repairs. To date 180 vehicles have either been repaired and passed an emissions test or are no longer operating in northern Virginia.

In October 2006 DEQ began issuing notices to vehicles that met clean screen criteria. Vehicles that receive clean screen notices are viewed as having a passing emission test and not required to receive an emission test in the near future. To date, DEQ has issued 185 clean screen notices.

Virginia currently does not receive credit in its State Implementation Plan for conducting the on-road emissions testing program. DEQ has contacted other states conducting on-road emissions testing and has concluded that although there are substantial benefits to the program, many of these benefits are not measurable, making it difficult to obtain credit for this program.

The ORE program has provided valuable information about fleet emissions in northern Virginia over time and as compared to information available for non-I/M (and non-ORE) areas. Data from the ORE program indicate that the biennial emissions inspection program has been successful in reducing vehicle emissions.

---

[1] DEQ is using the term On-Road Emissions (ORE) testing for the program in place in Virginia. The term Remote Sensing Device (RSD) has been used in the literature and by some other states to describe similar programs. This report uses the term remote sensing or RSD in reference to the process or to the remote sensing equipment itself.

Preliminary information indicates that modest improvements in identification of high emitting vehicles may be achieved through changes in monitoring sites (van location) and the ORE standards. DEQ has increased the ORE program effectiveness through recent changes in monitoring sites and has begun evaluating the ORE emissions standards.

DEQ plans to operate the ORE program for two more years through the existing contract term with Environmental Systems Products, Inc. (ESP), which is due for renewal in February 2008. Additional funding may be required for operation of the program beyond 2009.

BACKGROUND

Federal Requirements

The 1990 Federal Clean Air Act Amendments require that Inspection and Maintenance (I/M) Programs be implemented in urbanized areas exceeding the National Ambient Air Quality Standards for ozone and/or carbon monoxide (CO). The Federal Clean Air Act requires implementation of an enhanced I/M Program in the census-defined Washington DC Metropolitan Statistical Area. In Virginia, this area includes the cities of Alexandria, Fairfax, Falls Church, Manassas, and Manassas Park, and the counties of Arlington, Fairfax, Prince William, Loudoun, and Stafford. Federal regulations also require that a nominal 0.5% of the vehicles subject to an I/M program also be subject to "on-road testing." Federal regulations require that on-road testing be part of the emissions testing program, "but it is to be a compliment to testing otherwise required." *See* 40 C.F.R. 51.371.

Biennial Emissions Inspection Program

DEQ currently operates a decentralized enhanced I/M program in the Northern Virginia area consisting of approximately 466 independently owned inspection stations. All gasoline fueled vehicles less than 25 years old and up to 10,000 pounds gross vehicle weight rating (GVWR) are required to pass an emissions test or receive a waiver biennially before their motor vehicle license plates can be renewed. Currently, vehicles of model year 1996 and newer, with up to 8,500 lbs. GVWR are required to receive the on board diagnostic (OBD) test. Vehicles over 8500 lbs. GVWR may receive an OBD test if they are so equipped. Older vehicles, currently model years 1983 through 1995, receive a two-mode Acceleration Simulation Mode (ASM-2) test if they are able to be tested on a single axle dynamometer. Other vehicles receive a two-speed idle (TSI) test. In addition, all gasoline fueled vehicles must pass a gas cap pressure test, a visual inspection of applicable emissions control equipment components, and a pre- and post-inspection check for visible emissions. In July 2007, DEQ began testing light duty diesel vehicles (up to 8,500 lbs GVWR) of 1997 and newer model years using the OBD test.

On-road Emissions Testing Outside Virginia

Although several states are doing a nominal amount of on-road emissions testing to satisfy the EPA requirement of monitoring 0.5% of the fleet, only three other states have had large scale programs. Texas has operated a high emitter identification and repair program similar to Virginia's program since 1999. Missouri operated a clean screen only remote sensing program from 1999 to Fall 2007. Colorado has operated a clean screen only remote sensing program since 2004. Colorado plans to implement a high emitter identification and repair program in January 2008. California's South Coast Air Quality Management District is currently evaluating data from an 18-month high emitter identification pilot project.

In other countries, Cuidad Juarez in Mexico has been using on-road emission testing periodically to issue high emitter fines since the late 1990s. Korea, Taiwan, India, Japan, China, New Zealand, the United Kingdom, Austria, and Sweden are working on or have recently completed pilot projects and studies utilizing remote sensing technology.

Additionally, studies in Nogales, Arizona and Boston, Massachusetts indicate that remote sensing devices may be used to identify high emitting heavy duty diesel vehicles.

Virginia On-Road Emissions Testing

In 2004 DEQ contracted with Environmental Systems Products, Inc. (ESP) to collect emissions data using the RSD-4000 and later the RSD-4600 remote sensing devices (RSDs) (See Appendix A) in the Northern Virginia I/M program area and in certain non-I/M areas. On-road emissions testing is used to enhance the effectiveness of the existing I/M program as follows:

- Identify high emitting vehicles within the I/M area that may have received inadequate repairs or undergone catastrophic emission control system failures, thus requiring repairs in between normal inspection cycles. This process is known as high emitter identification.
- Identify high emitting vehicles that are registered in Virginia, but outside the Northern Virginia I/M area and that operate primarily within the program area. These vehicles must be brought into compliance with I/M standards.
- Identify very clean vehicles within the I/M area that have much lower than average emissions, potentially postponing their next regularly scheduled biennial emissions inspection test. This process is referred to as "clean screening."
- Identify vehicles that are registered outside Virginia, but operate primarily within the program area and are high emitters. These vehicles can be referred to authorities in the states in which they are registered concerning compliance with I/M standards.

- Evaluate fleet emissions trends and I/M program effectiveness. This entails collecting "no-I/M" baseline emissions data in the non-I/M areas of Richmond and Tidewater Virginia. Emissions trends can be analyzed by comparing test results collected in previous years and with results recorded in earlier studies such as "Virginia Remote Sensing Device Study – Final Report" (February 2003).

2006 On-Road Emissions Testing Results

To support the accomplishment of these program goals, ESP collected emissions data in the Northern Virginia I/M Program area starting in November 2004. ESP also sampled in the Richmond and Tidewater areas for the purpose of establishing a no-I/M baseline emissions profile. Results for the full calendar year of operation, 2006, were compiled and analyzed.

Following are the key conclusions drawn from this analysis:

- The program met its data collection goals for 2006. Over 800,000 measurements were attempted and over 296,000 unique vehicles were measured during the year (see Appendix D). Valid RSD measurements were made on 11% of the Northern Virginia I/M fleet.
- Vehicles registered in Virginia's I/M areas had significantly lower hydrocarbons (HC), carbon monoxide (CO), nitrogen oxide (NOx or NO) and particulate emissions[2] than vehicles registered in Virginia's non-I/M areas (see Appendix B1).
- The vehicle fleet in the I/M area is newer than the fleet in the non-I/M area.
- The introduction of OBD vehicle design requirements (generally model years 1996 and newer) has resulted in significantly lower emissions of HC, CO and particulates.
- Average emissions of HC, CO and NOx were lower in 2006 than in 2005 in both the I/M and non-I/M areas. This improvement in emissions is partially offset by an increase in the number of vehicles.

Appendix C shows the observation sites used during 2006 and Appendix D gives overall observation statistics.

HIGH EMITTER IDENTIFICATION

Identifying High Emitters

DEQ began implementation of the high emitter identification program on August 1, 2006. Pursuant to 9 VAC 5-91-180, vehicles can be identified as high emitters in two ways: 1) two hit scenario, where a vehicle is observed as a high emitter two days within 120 days, and 2) one hit scenario, where a vehicle is identified as

[2] The remote sensing equipment measures a "smoke factor" by means of ultraviolet light attenuation, similar to opacity in the visual light range. This measurement correlates well with particulate matter concentration in the 2.5 micron range.

a high emitter once and has also been identified as having a high probability of being a high emitter based on emissions test history of its particular make and model, or high emitter index (HEI). The high emitter index is calculated quarterly by DEQ based on the previous year of emissions test data.

High Emitter Standards

An important issue for a high emitter identification program is to minimize the number of vehicles that are identified as high emitters by on-road emissions testing, but then pass the follow-up confirmation emissions test. On-road emissions standards that are too stringent could cause vehicles that do not need repairs to be identified as high emitters. At the same time, on-road emissions standards that are too lenient will not identify many truly high emitting vehicles. To minimize the number of "false positives" while not unduly reducing the high emitter identification rate, DEQ has taken two approaches, 1) selection of on-road emissions standards that are comparable to the I/M test tailpipe standards, and 2) review of individual vehicle biennial emissions test history.

With respect to on-road emissions standards, DEQ's contractor analyzed past on-road emissions data and compared them to biennial I/M test results. This information was used to determine the on-road emissions standards for each of the emissions gases (HC, CO, and NOx)[3] which would minimize the number of confirmation test passes (or false positives), while maximizing the high emitter identification rate. Setting the on-road emissions standards as a linear function of the tailpipe test standards was determined to be better than using a single standard for all vehicle sizes, as had been done in some other state programs. (Tailpipe test standards are a function of vehicle type, model year and either vehicle weight or engine size.) Using these on-road emissions standards, DEQ has attained a lower percentage of confirmation emissions test relative to results in other studies. Nonetheless, a certain number of initial confirmation test passes or "errors of commission" will always occur due to tailpipe test variability, on-road emission measurement variability (background interference and emissions / speed--acceleration synchronization), vehicle drive mode variability, and vehicle emission control variability. DEQ is currently working with our ORE contractor to analyze ORE and I/M test data in order to further refine the ORE standards so as to more accurately identify high emitting vehicles. Initial results indicate that modest improvements can be made.

With respect to individual vehicle biennial emissions test history, DEQ is carefully comparing past emissions test results with the on-road emissions measurements for potential high emitters in order to weed out likely "false positives." For example, one vehicle with a clean I/M program emissions test history was determined to be garaged within one-half mile of the remote sensing device at which it was observed as a high emitter. The high on-road emissions

[3] DEQ has not yet set ORE standards for smoke factor. Smoke factor data is being evaluated to determine whether standards could be developed. Such standards would have to be implemented through a change in the I/M regulations at 9 VAC 5-91-180.

measurements were determined to be consistent with cold startup conditions, and the high emitter notification was nullified. DEQ hopes to be able to automate some of these kinds of determinations as more data become available.

Notifying High Emitters

Vehicles identified as potential high emitters are sent a notice of violation (NOV) advising them to obtain a confirmation test at a regular emissions inspection station and get repairs if needed within 30 days. If the vehicle passes the initial confirmation test, no test fee is charged. If the vehicle fails the confirmation test the owner is required to get the necessary repairs and have the vehicle re-inspected. If the vehicle does not ultimately receive a pass or a waiver (based on repair costs) the owner is subject to a fine of up to the minimum waiver expenditure (currently $680).

Initial High Emitter Identification Results

From August 1, 2006 through November 7, 2007, the on-road emissions testing program has identified 218 vehicles as high emitters and sent notices to the owners. Of these, 132 vehicles received a confirmation test (including four regular emissions tests). Of these 132 tests, 62 vehicles passed the initial test and 70 failed. It is not known how many of the passing vehicles received repairs prior to the confirmation test. For the vehicles which did not receive a confirmation test, in 33 cases the NOVs were either returned as "address unknown, no forwarding address" or DEQ was notified that the vehicle was sold or taken off the road (deregistered). Eighteen vehicles were "past due" (over 30 days had passed since issuance of the NOV) and legal action was taken against the owners. Fines totaling over $11,000 have been assessed. The remaining vehicle owners have not yet responded or are awaiting repair resolution but were not yet overdue at the time of this report.

Overall, 66% of the vehicles identified as high emitters (not pending action or unresolved) were either repaired and retested and passed (or received a waiver) or were taken off the road by virtue of being sold, junked or de-registered. These vehicles are no longer contributing to the air pollution in the Northern Virginia area. This does not include vehicles that received repairs prior to passing their confirmation tests.

CLEAN SCREENING

Identifying Clean Screen Vehicles

The clean screen component of on-road emissions testing provides for issuing an emissions test "Pass" to a limited number of vehicles observed by remote sensing as being very clean. Pursuant to 9 VAC 5-91-180, DEQ determines the maximum number of clean screen passes based on 5% of the number of on-road observations the previous month. Also, to limit the loss of emissions reduction "credit" received by the emissions inspection program as a whole, DEQ limits the clean screen passes to the number of high emitter NOVs issued the previous

month. A vehicle must be observed as very clean multiple times with no readings over the high emitter standards during a given time period to be considered under the clean screen provisions of the program.

Currently, vehicles that would receive the on board diagnostic (OBD) biennial emissions test are not eligible for clean screen. This is because the OBD system (required for light duty gasoline powered vehicles 1996 and newer, and light duty diesel vehicles 1997 and newer) is designed to detect vehicle emission control component problems before they necessarily become tailpipe emissions problems. Also, the OBD system checks emissions that are not necessarily measured by the DEQ biennial tailpipe test, such as cold start and certain evaporative emission problems. Thus, a vehicle could have an OBD system fault and still have clean tailpipe emissions when measured by remote sensing equipment. DEQ is concerned that issuing a clean screen pass to a vehicle which had an OBD fault indicated by an illuminated malfunction indicator light (MIL) could not only result in increased emissions, but could jeopardize the credibility of the clean screen program. DEQ intends to work with EPA and other states to determine how OBD vehicles could be reliably clean screened without adversely affecting the program integrity or program emission reductions.

Initial Clean Screen Identification Results

DEQ began implementation of the clean screen component of on-road emissions testing in October 2006 based on observations in September 2006. Based on the criteria described above, 185 clean screen notices have been issued in since October of 2006. (Note: Because a full month of observations must be compiled before the clean screen passes are determined for a given month, a determination for each month cannot be made until the following month.) For these 185 vehicles, DMV has logged a Pass in their emissions status record as of the date of last qualifying clean observation.

Clean Screening in Other States

Until September 2007, the Missouri “Gateway Clean Air Program” utilized a “rapid screen” component as part of its centralized emissions inspection program as a way to reduce the wait time at its centralized emission inspection stations. Owners that received a rapid screen notice could avoid going to their next inspection test if they paid the normal test fee of $24 to the centralized contractor. The centralized contractor ran both the emissions testing stations and the rapid screen remote sensing equipment. Missouri rapid screened approximately 15% of the fleet subject to I/M. Missouri determined that approximately 5% of the tailpipe test emissions reduction benefits for HC and CO, and 3% for NOx, were lost due to the rapid screen program. They did not calculate the effective loss for OBD testing. Missouri converted to a decentralized OBD-only program in Fall 2007 and did not continue with the rapid screen component due to the incompatibility of rapid screen and OBD results as well as the effect of reducing the testing volume at the new decentralized stations.

The Colorado Department of Public Health and Environment (CDPHE) added a clean screen component to it's I/M program in late 2004. As with Missouri, Colorado has centralized, contractor-run I/M inspection stations and, similarly, clean screen candidates must pay the full test fee of $25 to receive a clean screen pass. CDPHE has found that 6% to 8% of the subject I/M fleet is eligible for clean screen. CDPHE estimates that they lose approximately one ton per day out of 89 tons per day in HC emissions reductions as a result of the clean screen component. Colorado does not need NOx reductions to achieve its air quality goals.

REPAIR ASSISTANCE

DEQ has allocated $300,000 per year to fund a repair assistance component of the ORE program. Owners of vehicles that are identified as high emitters by ORE testing can receive financial assistance to help cover the cost of emissions related repairs if the owners meet certain low income criteria.

Owners have 60 days from the date of the confirmation test pass or waiver to submit a financial assistance request form. An owner must have a valid driver's license, a current registration for the vehicle and a current safety inspection. Vehicles that are deemed to be commercial are not eligible for financial assistance.

With the submission of the assistance form, the owner must also supply all relevant documents supporting emissions related repairs for the vehicle. The owner may submit any confirmable amount of repairs for consideration, but the maximum benefit received will only be half the minimum waiver expenditure. An applicant must have an annual family household income of 133% or less of the current year Federal Poverty Guidelines amount.

The program has had two written requests for assistance this year but in both cases the family income was too high for consideration. DEQ received one verbal request for assistance, but the citizen never followed up with a written request. Improper documentation of repair work is another barrier that arises with requests for financial assistance.

DETERMINING "DISAPPEARED VEHICLE" STATUS

In Fall 2006 the EPA Office of Inspector General finalized an audit of several state I/M programs including Virginia. (see http://www.epa.gov/oig/reports/2007/20061005-2007-P-00001.pdf) As part of this report, EPA analyzed DEQ I/M program data for calendar year 2004. A primary concern of this report was the number of "disappeared vehicles" or vehicles which had received an emissions inspection fail, but with no subsequent pass or waiver. EPA was concerned that these vehicles may be circumventing the program, which could affect the

"compliance rate" used in determining emission reduction credits. DEQ was able to use remote sensing observation data, along with data from DMV and Carfax, to demonstrate that few of these vehicles were actually being driven in the I/M area. Of the 7014 vehicles identified by EPA as "disappeared vehicles," remote sensing data, in part, was used to determine that only about 2% were operating in the I/M area for more than one year.

EPA EMISSIONS CREDIT

DEQ has evaluated the emissions reduction credits attributable to ORE high emitter identification using the available EPA emissions models. The results have been minimal. Thus, DEQ is not taking credit for the on-road emissions testing program in its State Implementation Plan; rather, ORE is listed as a voluntary measure. DEQ believes, for several reasons, that the current EPA models may underestimate the actual benefits of the high emitter identification program as implemented in Virginia.

The current EPA model is based on assigning annual test emissions inspection program benefits to the portion of the fleet observed by remote sensing, and assigning biennial program benefits to the portion not observed by remote sensing. There is evidence to suggest, however, that the additional emission reductions attributed to an annual emission inspection program as compared to a biennial program is understated because vehicles appear to deteriorate more in the first year after repairs rather than linearly over two years. Additionally, the EPA model is based on assigning fixed on-road emissions standards to all vehicles based solely on model year and vehicle type. DEQ has developed a system of on-road emissions standards that provides a better method for taking into account actual on-road emissions.

Like Virginia, Texas is not taking credit for its on-road emissions testing program. Because Texas has an annual I/M program, the current EPA model will not even give an evaluation result of their program. Texas is having an independent assessment done of their program, which should be available in January 2008. A previous study indicated that the remote sensing program was not conducive to evaluating the annual I/M program because of the way the remote sensing site locations focused on high emitter identification.

In addition to the above differences in modeling methodology, there are on-road emissions testing benefits that are outside of the EPA modeling domain. For example, DEQ already has used ORE results to identify fraudulent emissions inspections. ORE evidence was presented to one vehicle emissions inspector who admitted "clean piping" or using the emission results of a different vehicle to obtain a pass. We believe that because of the ORE program, the frequency of such occurrences has diminished.

A similar benefit is the deterrent effect ORE has on faulty or incomplete repairs. Repair technicians are more likely to attempt better and longer lasting repairs, rather than just enough to pass the emissions inspection, knowing that they will have an unhappy customer if their vehicle were to be identified as a high emitter through ORE. Overall, DEQ believes the ORE program deterrent effect benefits are considerable although impossible to quantify.

DEQ staff participated in an EPA Federal Advisory Committee Act (FACA) committee charged with developing a strategy for states and EPA to use in transitioning I/M programs from tailpipe-testing systems to OBD-testing systems. A final report is due from the committee by the end of 2007, with ongoing work as needed until August 2008. The draft final report acknowledges the value of remote sensing augmenting OBD-only I/M programs.

Based on discussions with EPA and Texas Commission on Environmental Quality (TCEQ) staff, DEQ has concluded that remote sensing provides very limited emissions reduction credit for use in Virginia's air quality planning due to the low percentage of vehicles actually observed unless the number of remote sensing vans utilized is significantly increased.

ORE ISSUES IDENTIFIED

Increasing High Emitter Identification

In over fourteen months of operation, the ORE high emitter identification program identified only 218 potential high emitter vehicles out of a total of approximately 335,000 unique vehicle observations since August 2006 in the I/M area. This low identification rate (0.065%) is much less than the 2 percent fail rate that was originally anticipated, but is similar to the identification rate of 0.08% experienced in Texas during 2006.

One way to increase the number of high emitter vehicles identified is to make adjustments to the ORE emissions standards. As discussed above, simply increasing the stringency of the standards could lead to a higher percentage of vehicles passing the confirmation test (or false positive). DEQ is currently working with the RSD contractor to evaluate the ORE emissions standards to more efficiently identify high emitters. Based on data from other state programs, however, DEQ does not believe that this is a viable means for significantly improving the program.

Another way to increase the high emitter identification rate is to alter the choice of RSD van sites. For example, currently most sites utilize freeway on- and off-ramps. Recent studies indicate that vehicles using these highways tend to be cleaner than vehicles using predominately "surface roads." There are two issues with increasing observations on surface roads. First, the northern Virginia area does not have many single lane roadways, which are best for remote sensing equipment placement. Second, DEQ's contract with ESP is based on paying by

unique vehicle observed. Thus ESP has a financial incentive to use high volume sites, as opposed to high emitter sites. Nonetheless, ESP has been very accommodating in working with DEQ staff to try new site schemes. Changes instituted in June of 2007 appear to have increased both the number of unique observations and the number of NOVs issued.

DEQ believes that the only effective way to increase the number of high emitters identified is to increase the number of remote sensing van-days. Increasing the number of van-days would require an increase in contract dollar expenditure, currently $300,000 per year. Expansion of the ORE program van-days would require additional funding, beyond the current resources of the "IM fund" which is funded through a $2 per year fee assessed at registration for vehicles subject to the I/M program. This fund supports the entire DEQ Air Check Virginia program expenses and related air quality needs. Texas utilizes another method for funding its ORE program. Texas receives a $6 rebate from its decentralized inspection stations for each OBD test. The OBD test is much shorter and does not involve large equipment operating expenses. Another funding option could be charging for clean screen passes. Changes in the Virginia Code would be required for either option.

Increasing Clean Screening

The number of clean screen passes issued is currently limited to the number of high emitters identified so as not to lose any emissions reduction credit. Thus, increasing the number of high emitters identified would allow a commensurate increase in the number of clean screen passes issued. Clean screen candidates are currently limited to non-OBD vehicles, however, which are getting older and perhaps less certain to be "clean screenable." Increasing the number of clean screens would have to require allowing the clean screening of OBD vehicles, with the adverse effects mentioned earlier such that greatly increasing the number of clean screens is not consistent with the overall emissions reduction needs of the northern Virginia air quality plan.

RSD Technical Advances to Increase the Number and Quality of Observations

Requiring a manned remote sensing van unit to obtain ORE data has proven to be a large expense. Unmanned remote sensing units have been under development for several years, and DEQ had originally hoped to be able to incorporate them into the ORE program. To date no such unmanned device is in production. ESP is expecting to complete development of a new remote sensing unit, the RSD-5000 platform, which promises to allow for wireless, remote monitoring of vehicles. The development of the unit is expected to be complete in 2008 and also will allow for greater use of remote sensing technology in limited roadway spaces.

Improvements in remote sensing equipment accuracy will enable fine tuning of the ORE program standards, thus increasing both the number of total

observations as well as the percentage of high emitters identified. Two existing sources of error in remote sensing measurements are background interference and time alignment between the speed/acceleration and emissions measurements. The RSD-4600 remote sensing unit which ESP provided to DEQ in Spring 2006 has allowed better calibration procedures, which has improved data quality with respect to background interference. The speed/acceleration to emissions measurement issue is more complicated. It involves determining the load on the engine (i.e., the speed/acceleration readings) at the exact moment the emissions that are to be sampled were generated. One way to do this is to use two speed/acceleration bars. The RSD-4600 unit has this capability but the software to perform the calculations has not been finalized.

ORE COST EFFECTIVENESS

Benefits

It is difficult to accurately determine the value of the ORE Program benefits. In 15 months of operation the ORE program caused 180 vehicles to be either repaired or taken off the roads in Northern Virginia. Although this number is small in comparison with the approximately 50,000 vehicles that fail their biennial emissions inspection every year, these 180 vehicles were very high emitters. The failing levels for exhaust pollutant gas concentration in the ORE program are 6 to 8 times the failing levels of the tailpipe test. These vehicles would have continued to operate for another year or more before having to take a regular I/M test.

Other benefits are more difficult to determine. For example, although 33 percent of the vehicles that received an NOV passed their confirmation test, we know that many of these received repairs prior to the confirmation test based on conversations with some vehicle owners. There is a strong incentive to do so since there is no $28 fee if a vehicle passes the confirmation test. In order to better gauge this effect DEQ conducted a telephone survey in Spring 2007. Few vehicle owners could be contacted, however, making the results of the survey invalid. Other intangible benefits include the deterrent effect on improper biennial inspections and improper repairs.

Costs

Unlike the benefits, the costs of running the program are better defined. As of October 2007, total non-staff expenditures for the ORE program have been:

ORE contractor fees	$1,031,235.00
Vehicle Inspection Database	$ 315,411.00

These costs can be broken down into one-time startup costs, including making changes to the Vehicle Inspection Database (VID), and on-going operation costs. On-going costs include one dedicated staff position. The on-going operation costs could increase slightly due to changes in van site location requirements, as

discussed above. They also could decrease substantially if unmanned remote sensing units become a reality. Costs associated with the ORE program are summarized below:

<u>Startup</u>		
VID system development	$ 313,734.50	one-time
ORE data to July 2006	$ 706,000.00	one-time
VID operating expense	$ 8,000.00	pre-ORE enforcement startup
<u>On-going</u>		
Dedicated Staff	$ 70,000.00	annual
VID operating expense	$ 12,000.00	annual
ORE data	$ 300,000.00	annual
Repair assistance	$ 100,000.00	annual (if requests are received)

(Although set aside, no funds for repair assistance have been expended to date.)

Conclusions

DEQ will continue to operate the on-road emission testing program through the existing contract with ESP, which will terminate unless renewed in February 2008. DEQ will continue to evaluate the costs and benefits of keeping the ORE program operational beyond these two years.

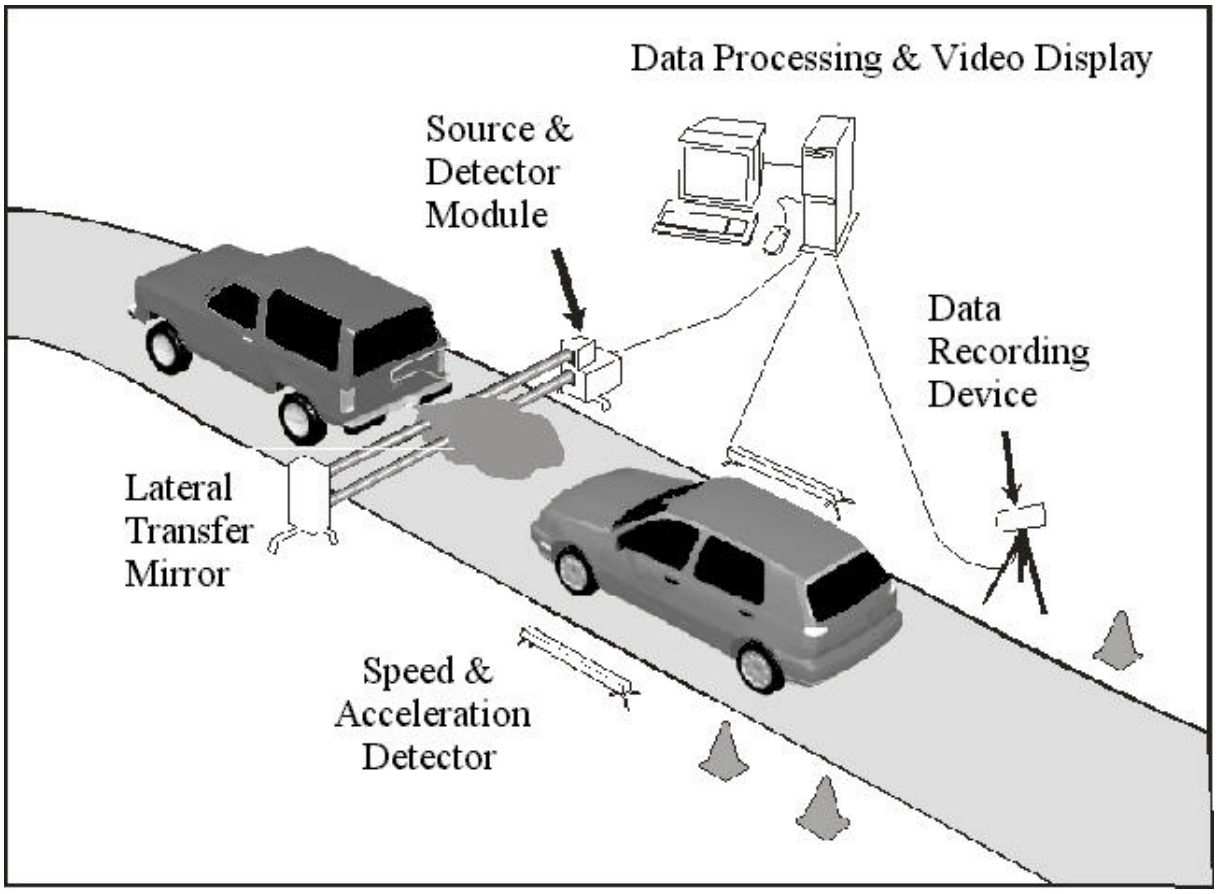
Significantly increasing the number of high emitting vehicles identified as well as the number of clean screened vehicles would require an increase in remote sensing van-days. Current funding sources cannot accommodate such an increase.

DEQ recommends keeping the provisions for ORE repair assistance in place even though there have been no requests to date because there is no cost to do so. However, DEQ suggests limiting the funds available for repair assistance to $100,000 per year based on internal budget needs and as funds are available.

APPENDIX A: REMOTE SENSING DEVICES

The RSD device detects vehicle emissions when a car drives through an invisible light beam that the system projects across a roadway. Figure A-1 illustrates the remote sensing equipment set-up. The process of measuring emissions remotely begins when the RSD device Source & Detector Module (SDM) sends an infrared (IR) and ultraviolet (UV) light beam across a single lane of road to a lateral transfer mirror. The mirror reflects the beam back across the street (creating a dual beam path) into a series of detectors in the SDM.

Figure A-1 Remote Sensing Device Set-Up



Fuel specific concentrations of HC, CO, CO2, NOx and smoke factor are measured in vehicle exhaust plumes based on their absorption of IR/UV light in the dual beam path. During this process, the data-recording device captures an image of the rear of the vehicle, while the Speed & Acceleration Detector measures the speed and rate of acceleration of each vehicle.

The RSD units are housed in fully outfitted Chevrolet vans. These vans are equipped with heating/cooling, a generator, and adequate storage for all components. The vans carry a full compliment of road safety equipment and tools for making small repairs. The vans are equipped with additional lighting for testing during pre-dawn and post dusk hours.

The majority of the data for the Virginia ORE program was gathered using the EPS RSD-4000 remote sensing unit. The RSD-4000 includes many features not available in the model used in a 2002 pilot project including:

- A longer beam range for safer, more versatile deployment
- A fuel specific smoke factor measurement using a UV wavelength that senses the fine particles in the 2.5 micron range that are invisible to traditional visible light opacity meters

The RSD-4600 unit was voluntarily provided to the Virginia ORE by ESP in Spring 2006. In addition to the features of the RSD-4000, the RSD-4600 provides:

- an improved calibration regime which can be completely automated
- compatibility with dual speed/acceleration bars.

APPENDIX B1: AVERAGE FLEET EMISSIONS

Remote sensing data (RSD) can be used to characterize the fleet emissions. These data are helpful in designing effective strategies to reduce emissions. This is particularly relevant now that most vehicles are tested using the OBD test which does not provide actual tailpipe emissions data.

The following charts show the fleet total emissions by model year in terms of percent of total fleet emissions. The average per vehicle emission readings have been weighted by the number of vehicles observed. This method takes into account both the number of vehicles registered and the lower per-vehicle miles traveled for older vehicles. The charts also show the additional emissions in non-I/M areas (non-IM delta). Thus, the green (darker) bars indicate the relative distribution of emissions of each model year in the northern Virginia I/M area and the whole bar represents the distribution in the non-I/M areas. In a few cases the non-IM delta is negative where the average vehicle emissions for that model year were actually less in the non-I/M areas.

These data do not take into account differences in fleet makeup between the I/M and non-I/M areas. For example, there may be a high percentage of SUVs or light duty trucks which prior to model year 2004 often had less stringent new vehicle certification standards.

Figure B1-1: Model Year Carbon Monoxide Contribution

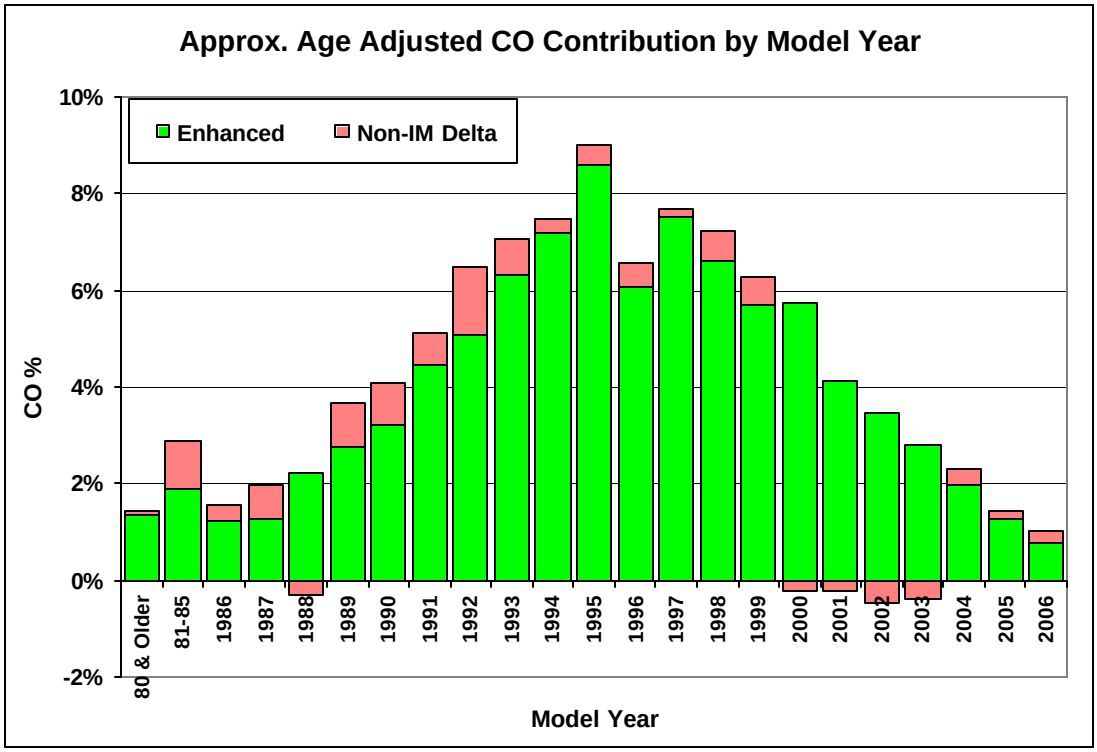


Figure B1-2: Model Year Hydrocarbon Contribution

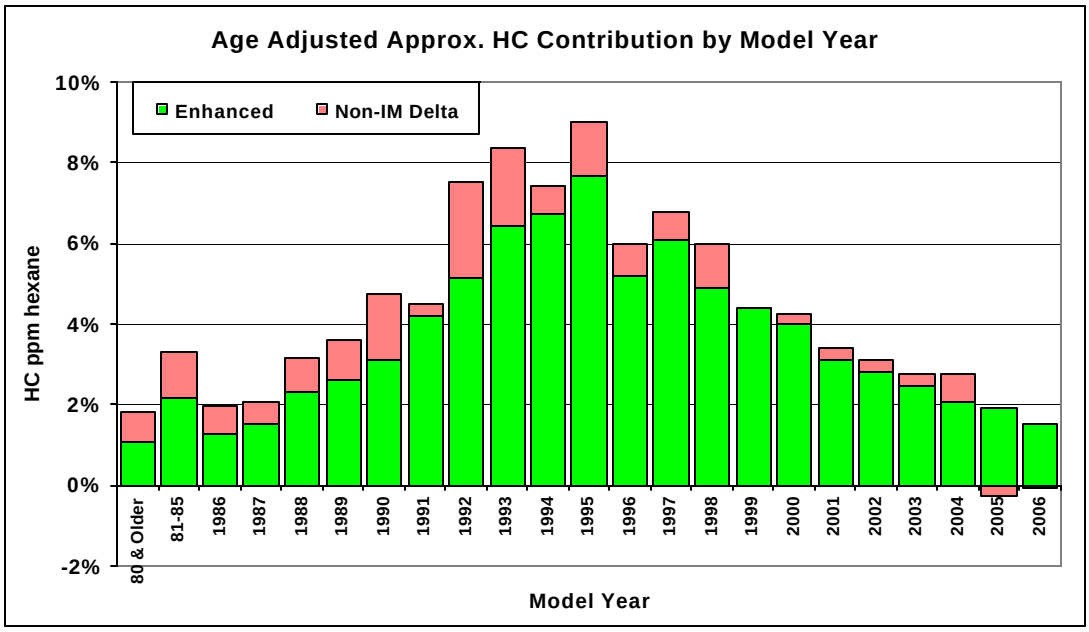


Figure B1-3: Model Year Nitrogen Oxides Contribution

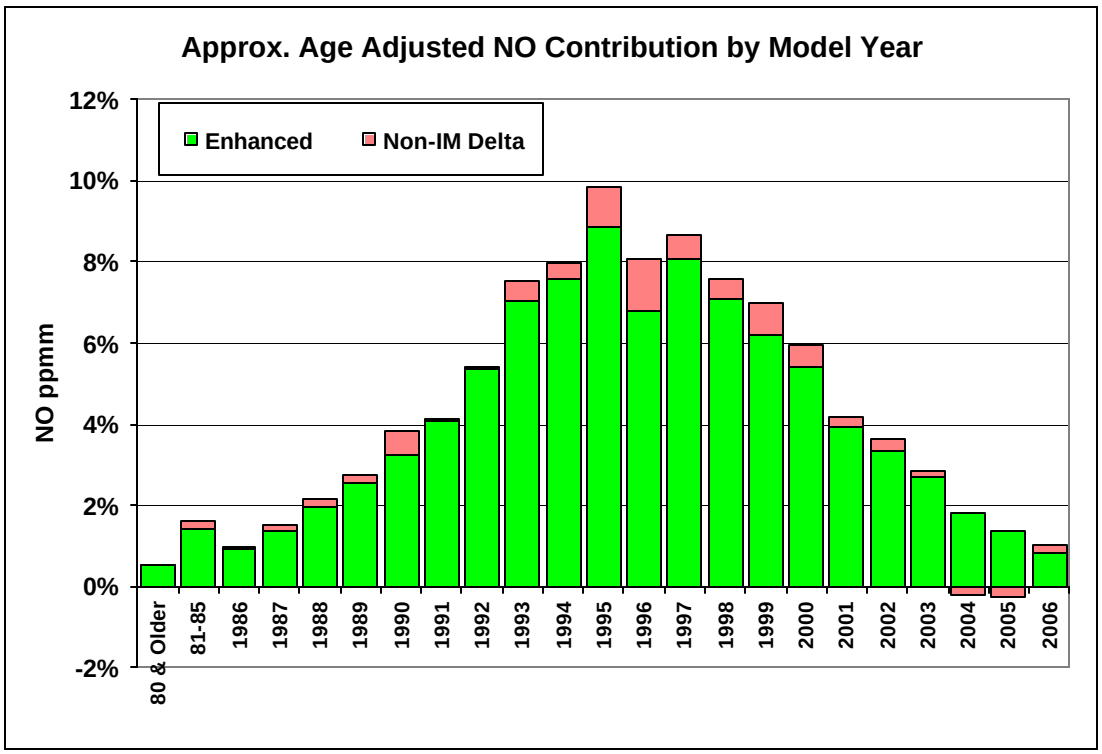
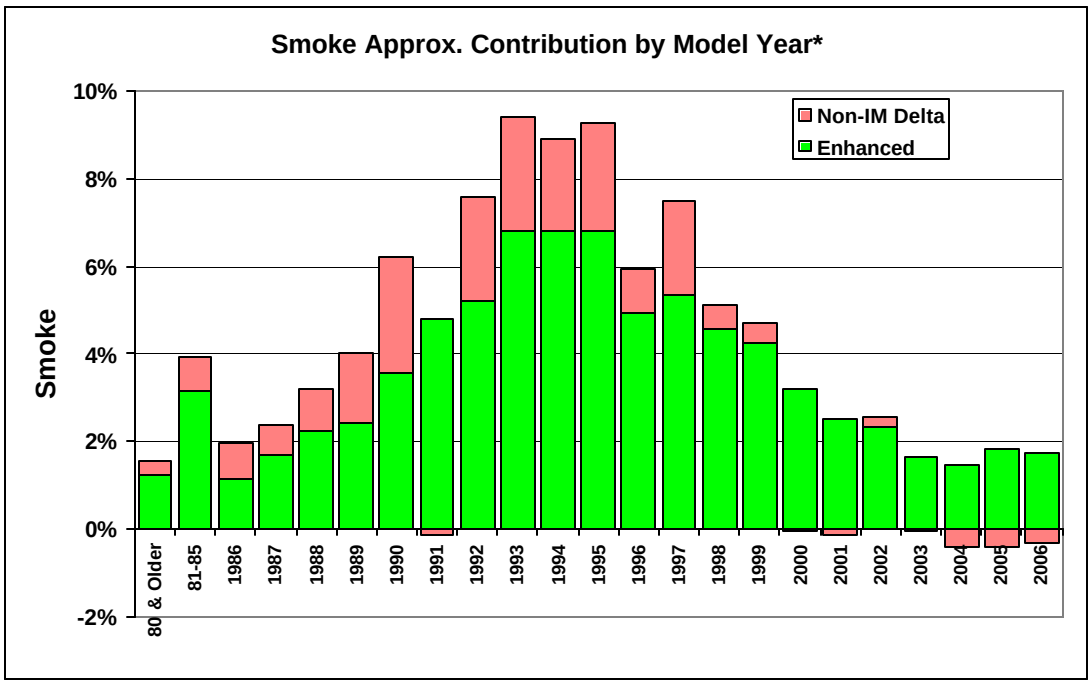


Figure B1-4: Model Year Smoke Factor Contribution



Excess emissions are defined as the emissions over and beyond the normal vehicle emissions and that theoretically can be eliminated by inspection and maintenance. The non-IM delta bars provide a rough estimate of the actual excess emissions reduction attributable to the Virginia I/M program as a whole.

The above charts show that all but the newest vehicles contribute to excess emissions. It is significant that older, pre-OBD vehicles (1995 and older) contribute the vast majority of the excess CO and HC emissions although they constituted only 20% of the fleet subject to biennial testing in 2006. For NO emissions it appears the 1996 and newer, predominately OBD vehicles (80% of the fleet), produce slightly more excess NO emissions than the pre-OBD vehicles (20% of the fleet).

Currently about 50% of the NOVs issued as a result of on-road testing go to vehicles equipped with OBD. This differs from the results of regular biennial inspections where OBD vehicles contribute 62% of the total failures. This difference is consistent with the OBD test being a more appropriate test for newer vehicles.

APPENDIX B2: COMPARISON OF I/M VERSUS NON-I/M AREAS

Remote sensing can be used to gauge the effectiveness of an I/M program by measuring the difference in emissions between the I/M area and non-I/M areas. Figures B2-1 through B2-4 below show a comparison of emissions for the two groups. Two scenarios are presented:

- Registered vehicles, and
- Age adjusted.

The On-Road scenario reflects averages of observations of vehicles registered in the area. The Age Adjusted scenario takes the average emissions by model year for the area and multiplies them by the combined model year fractions for both the I/M and non-I/M areas. This is intended to eliminate reductions that occur solely because one area has more new vehicles than the other area. It could be argued the mere presence of an I/M program creates a shift to newer vehicles, so the adjustment may partially hide some I/M benefits. The difference between the I/M and non-I/M registered On-Road fleets is 19% for CO, 28% for HC, 16% for NOx and 31% for smoke factor. This could be interpreted as indicating the true benefit of the Air Check Virginia program. The age adjustment reduces the apparent difference between the I/M and non-I/M areas to roughly 8% for CO, 17% for HC, 8% for NOx and 20% for smoke factor. This could be interpreted as indicating the benefit of the repairs done to receive an emissions pass.

Figure B2-1: I/M vs. Non-I/M Carbon Monoxide

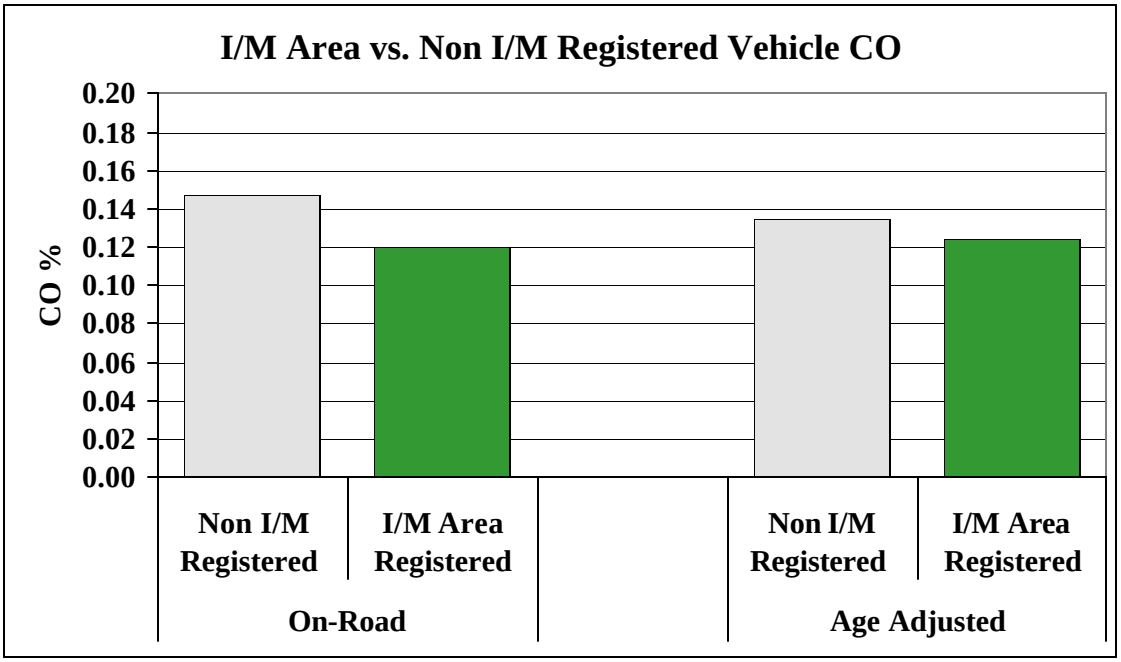


Figure B2-2: I/M vs. Non-I/M Hydrocarbons

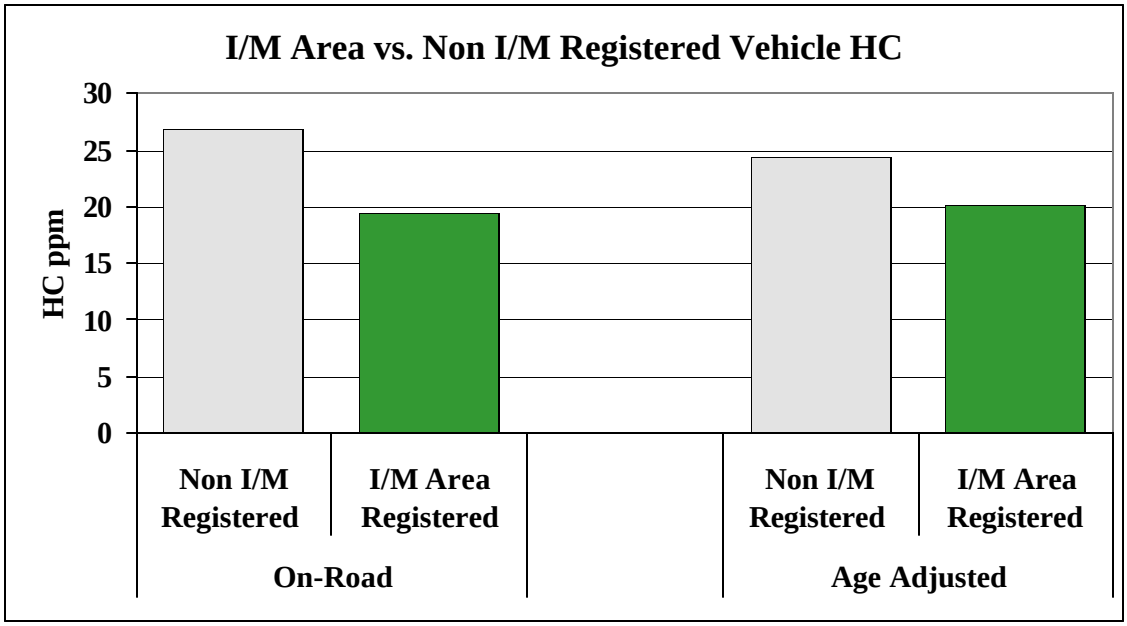


Figure B2-3: I/M vs. Non I/M Nitrogen Oxides

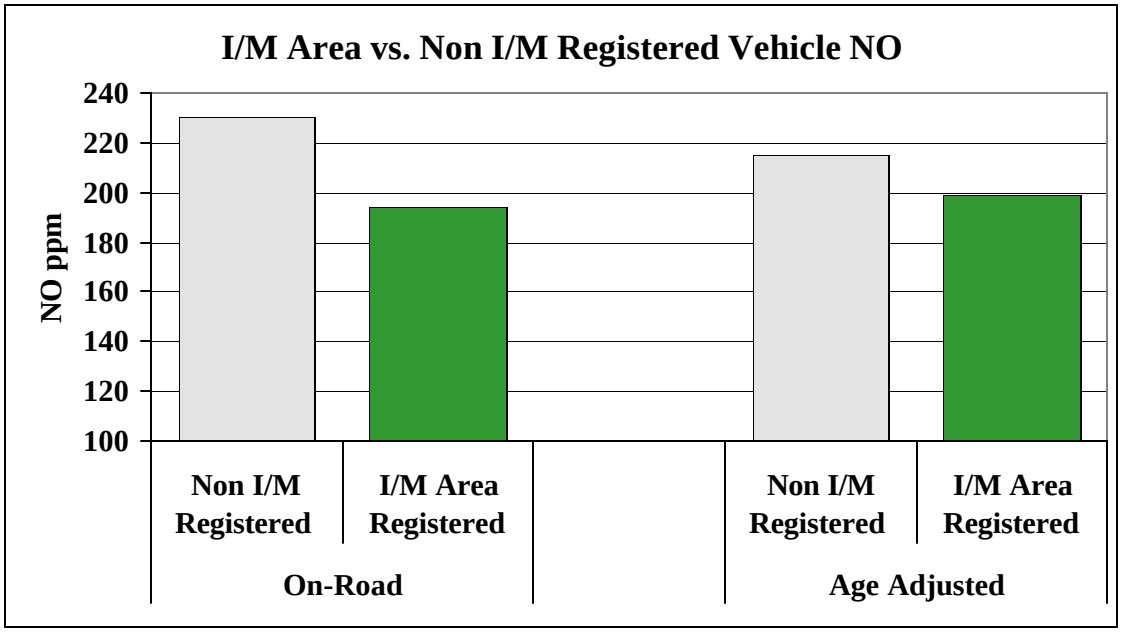
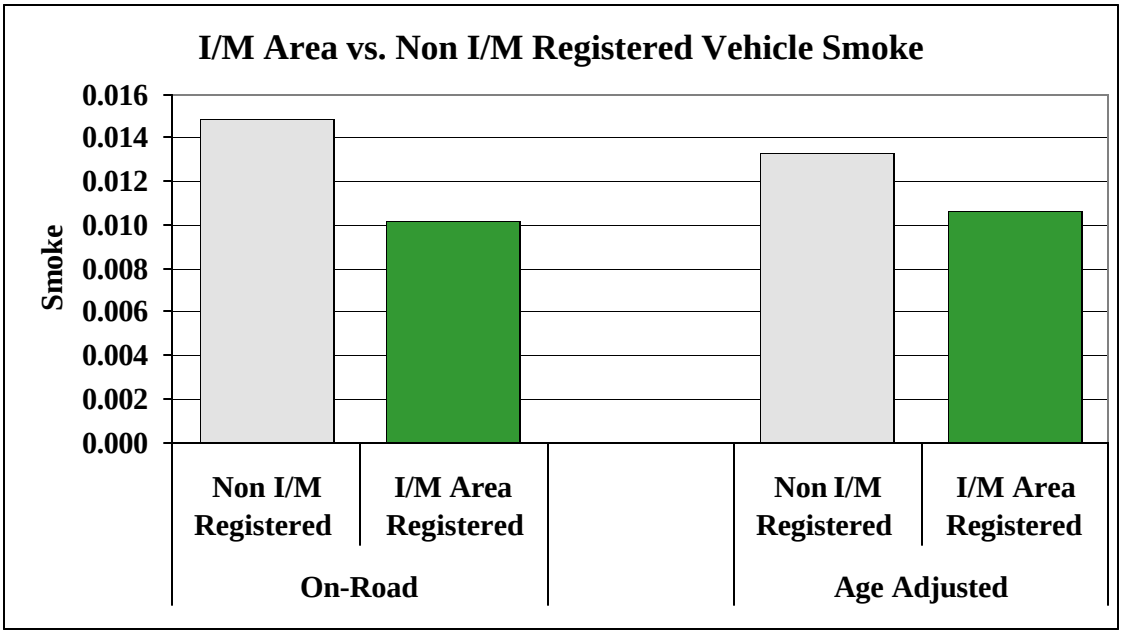


Figure B2-4: I/M vs. Non I/M Smoke Factor



2005 to 2006 Comparison

Comparing remote sensing data from one calendar year to another can be a valuable tool. Average emissions should show a decrease, although fleet makeup can influence this. An example would be an increase in heavy duty (i.e., over 8,500 lbs GVWR) vehicles which are subject to less stringent new vehicle certification standards.

The RSD average emissions of the on-road fleets in I/M and non-I/M areas in 2005 and 2006 are shown in Table B2-1. Age adjusted values are also shown. The age-adjusted values are intended to show the I/M and non-I/M fleets on a comparable basis by assuming the same model year fractions existed in each area.

HC, CO and NO emissions are generally lower in 2006 than in 2005. The reduction is present in both I/M and non-I/M areas. Although average emissions remain higher in the non-I/M areas, the 2005 to 2006 reductions appear to be greatest in these non-I/M areas. This may be the result of the retirement of more high emitters from these areas.

Reductions in individual vehicle emissions levels are partially offset by increases in registrations and vehicle miles traveled. Increases in congestion also act to increase the total mass of emissions.

Reported average UV Smoke values increased from 2005 to 2006. Average per vehicle smoke emissions of the light-duty gasoline vehicle fleet are very small. Diesel vehicles are not included because DEQ did not require biennial I/M testing of light-duty diesel vehicles in 2006.

Table B2-1: 2005 and 2006 Average Emissions; I/M area versus non-I/M areas

		On-Road Fleet			Age Adjusted		
		I/M	Non I/M	I/M Reduction	I/M	Non I/M	I/M Reduction
CO %	2005	0.13	0.18	28%	0.14	0.16	13%
	2006	0.12	0.15	19%	0.12	0.14	8%
	% Change:	-10%	-20%		-12%	-16%	
HC ppm	2005	19	31	38%	21	27	22%
	2006	20	27	28%	20	24	17%
	% Change:	1%	-14%		-3%	-9%	
NO ppm	2005	220	303	27%	231	275	16%
	2006	194	231	16%	199	215	8%
	% Change:	-12%	-24%		-14%	-22%	
UV Smoke	2005	0.007	0.012	41%	0.008	0.011	25%
	2006	0.010	0.015	31%	0.011	0.013	20%
		n/a	n/a		n/a	n/a	

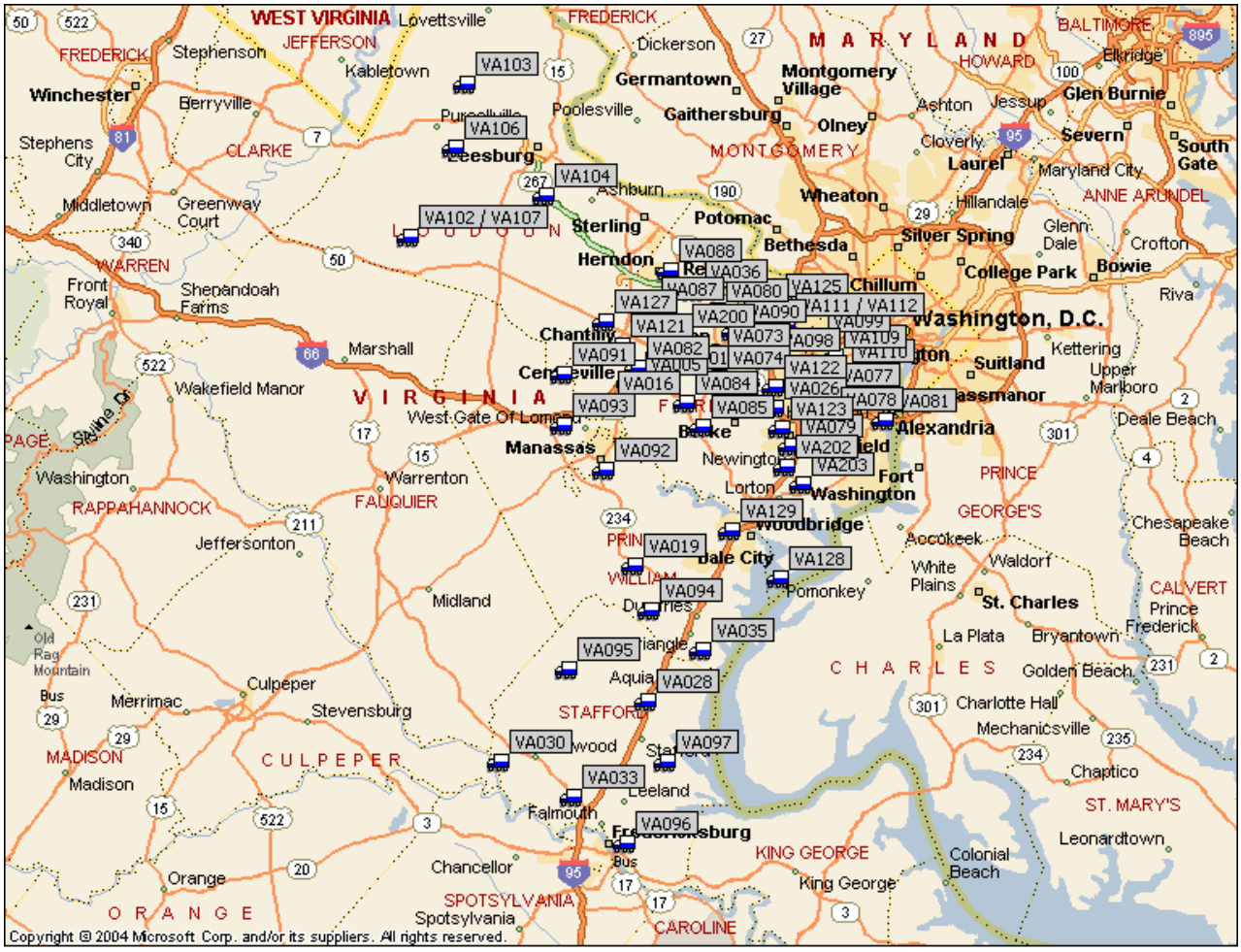
.

APPENDIX C: REMOTE SENSING SITES IN 2006

FIGURE C-1 SITES BY REGION

Region / Jurisdiction	Sites	Sessions
Northern Virginia:		
ALEXANDRIA	2	7
ARLINGTON	2	10
FAIRFAX	23	115
FAIRFAX CITY	2	8
FALLS CHURCH	1	8
LOUDOUN	5	15
MANASSAS	1	4
PRINCE WILLIAM	8	29
STAFFORD	6	24
Subtotal	50	220
Fredericksburg:		
FREDERICKSBURG	4	19
SPOTSYLVANIA	1	2
Subtotal	5	21
Richmond Area:		
HENRICO	3	9
RICHMOND	2	6
Subtotal	5	15
Tidewater Area:		
CHESAPEAKE	2	7
HAMPTON	2	7
NEWPORT NEWS	2	5
NORFOLK	1	3
Subtotal	7	22
Total	67	278

Figure C-2 Site Locations in Northern Virginia



(Note: Some sites are no longer in use.)

Figure C-3 Site Locations in Fredericksburg

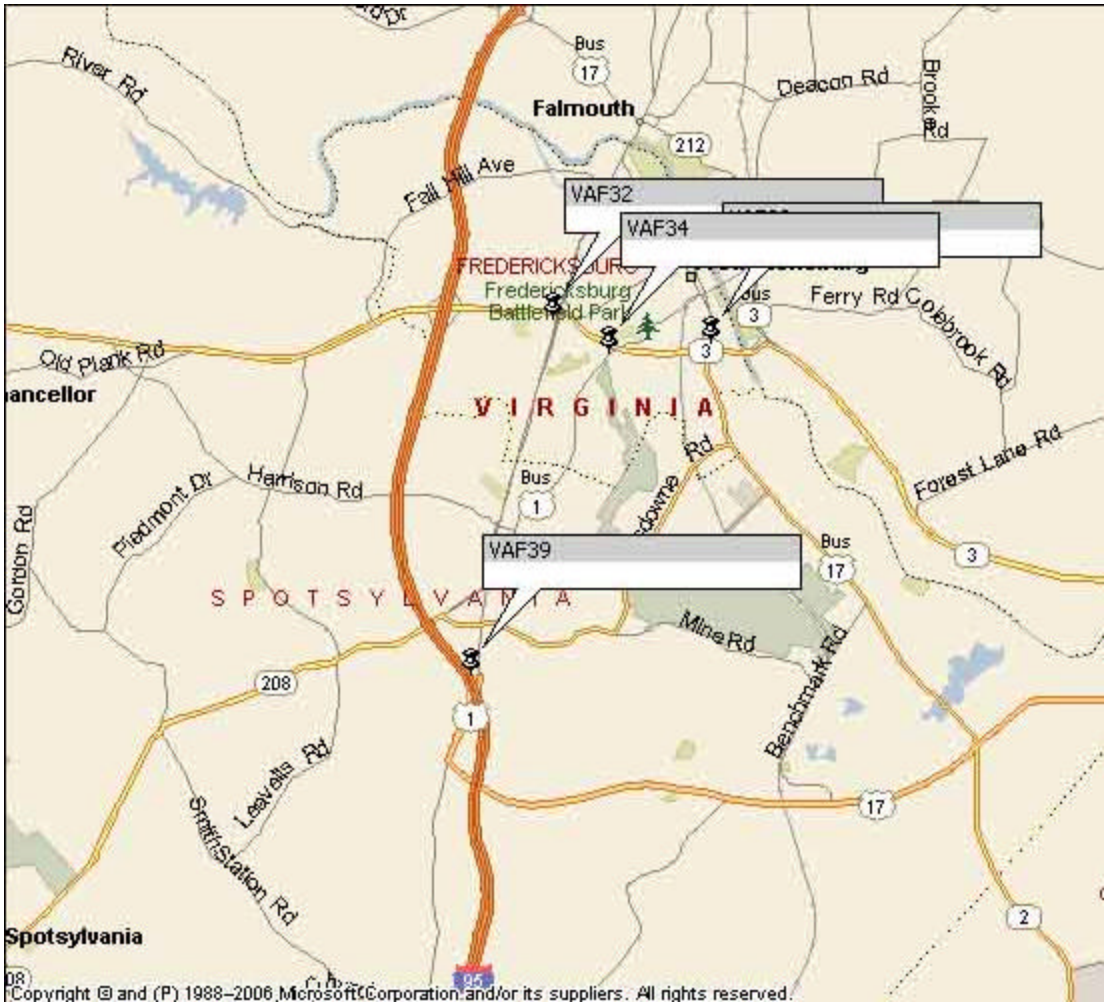


Figure C-4 Site Locations in the Richmond Area

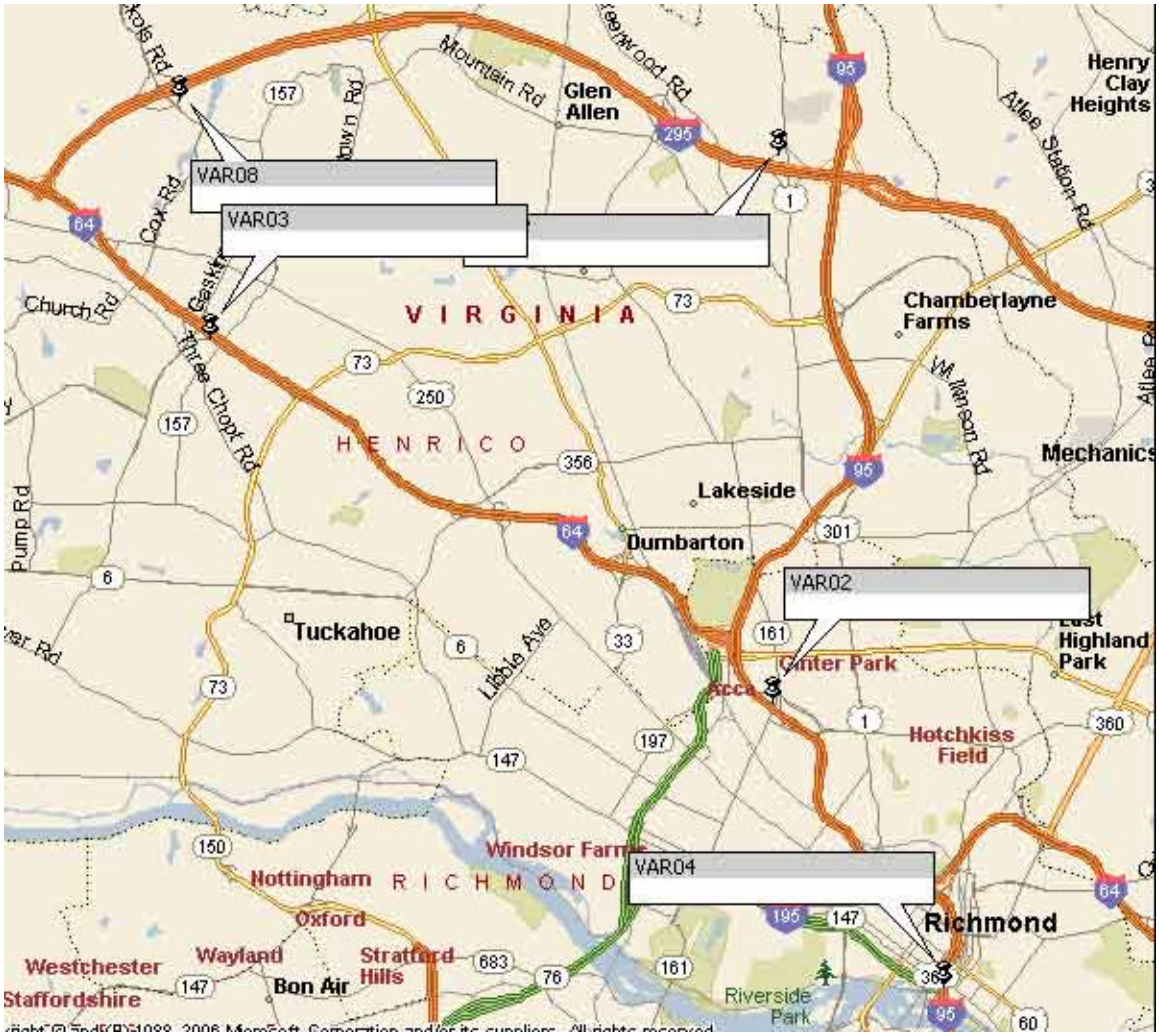
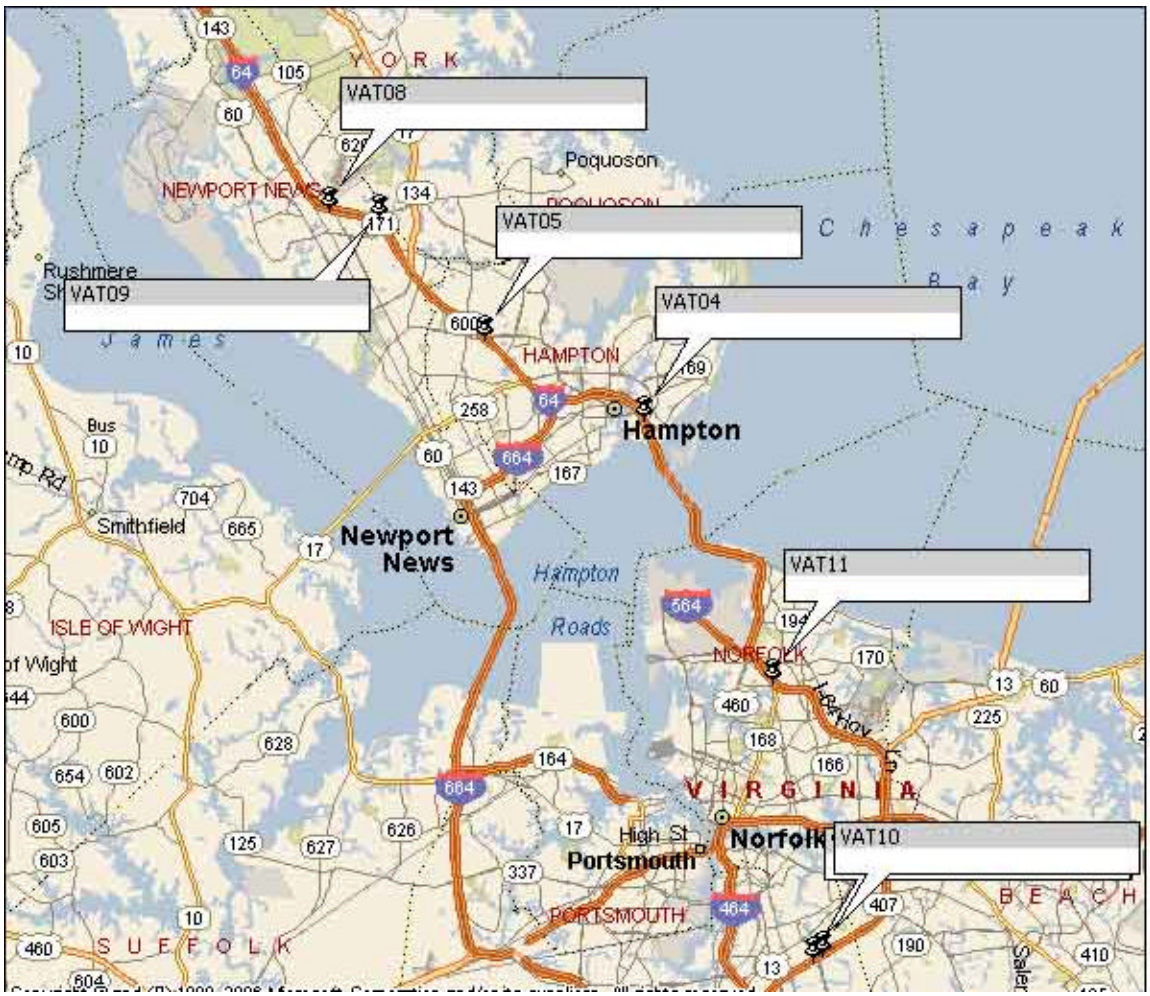


Figure C-5 Site Locations in Tidewater



APPENDIX D: Overall Program Statistics

Table D-1: Number of Remote Sensing Records by License Plate- 2006

Parameter	I/M Program Area	Virginia Non-I/M Area	Out of State	Total
Total Number of RSD Units Utilized	7	7	N/A	7
Total Number of Sites Utilized	50	17	N/A	67
Total Number of Van Collection Days Readings Taken	133	40	N/A	173
Total Number of Readings Taken	632,856	196,226	N/A	829,082
Total Number of Valid Readings Taken (Emissions, VSP, Audit, & License Plate Picture)	328,999	121,557	N/A	450,556
Total Number of Vehicles With "Unreadable" License Plates	34,077	10,596	N/A	44,673
Total Number of Readings With Readable License Plates	251,720	102,257	51906	405,883
Total Number of Readings With Matched License Plates by Site Jurisdiction	245,556	99,049	N/A	344,605
Total Number of Readings With Matched License Plates Registered in Enhanced Area	223,740	10,703	N/A	234,443
Total Number of Readings With Matched License Plates Registered in Non-I/M Area	21,816	88,346	N/A	110,162

Table D-2: Multiple Measurements - 2006

By Registered Jurisdiction and VIN or Out-of-State and Plate:	I/M Program Area	Virginia Non-I/M Area	Out of State	Total
Total Number of Unique Vehicles Identified	175,564	87,998	33,067	296,629
Total Number of Vehicles Identified Once	135,715	71,141	29,046	235,902
Total Number of Vehicles Identified Twice	27,898	13,122	3,091	44,111
Total Number of Vehicles Identified Three Times	7,719	2,782	617	11,118
Total Number of Vehicles Identified Four or More Times	4,232	953	313	5,498

Table D-3: Unique VINs Successfully Measured - 2006

	Unique Vehicles Successfully Measured by Registered Jurisdiction 2006		Light Vehicles Registered in Jurisdiction 2005		% Measured	
	Diesel	Gas & Other	Diesel	Gas & Other	Diesel	Gas & Other
Northern Virginia:						
ALEXANDRIA	73	12,044	800	132,956	9%	9%
ARLINGTON	54	7,798	992	129,907	5%	6%
FAIRFAX COUNTY	830	86,918	6,541	735,905	13%	12%
FAIRFAX CITY	22	1,684	159	21,133	14%	8%
FALLS CHURCH	8	1,597	115	16,142	7%	10%
LOUDOUN	414	17,563	2,893	193,849	14%	9%
MANASSAS PARK	28	821	143	9,378	20%	9%
MANASSAS	56	2,278	370	31,118	15%	7%
PRINCE WILLIAM	495	27,989	3,536	255,464	14%	11%
STAFFORD	345	15,360	1,466	86,786	24%	18%
Subtotal	2,325	174,052	17,015	1,612,638	14%	11%
Fauquier & Fredericksburg:						
CAROLINE	25	1,735	352	23,610	7%	7%
FAUQUIER	114	2,254	1,643	57,859	7%	4%
FREDERICKSBURG	48	3,230	243	17,291	20%	19%
KING GEORGE	24	1,217	312	18,621	8%	7%
SPOTSYLVANIA	270	17,834	1,335	96,282	20%	19%
Subtotal	481	26,270	3,885	213,663	12%	12%
Richmond Area:						
CHESTERFIELD	33	1,873	2,320	246,788	1%	1%
HANOVER	62	2,422	1,464	87,095	4%	3%
HENRICO	78	10,761	1,948	231,218	4%	5%
RICHMOND CITY	133	4,005	2,545	131,375	5%	3%
Subtotal	306	19,061	8,277	696,476	4%	3%
Tidewater Area:						
CHESAPEAKE	60	4,124	2,182	165,024	3%	2%
HAMPTON	26	3,583	1,190	104,475	2%	3%
NEWPORT NEWS	54	5,955	1,030	140,026	5%	4%
NORFOLK	37	4,243	1,038	157,041	4%	3%
PORTSMOUTH	8	397	626	66,763	1%	1%
VIRGINIA BEACH	89	6,859	3,210	332,197	3%	2%
Subtotal	274	25,161	9,276	965,526	3%	3%
Total	2,953	221,504	34,811	3,291,931	8%	7%