EFFECTIVENESS OF FREE BUS FARES ON FORECAST AIR QUALITY CODE RED DAYS

Interim Report

Prepared for

Northern Virginia Transportation Commission

December 31, 2003

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Each day during the portion of the year, in which high ozone levels may be expected to occur, the Metropolitan Washington Council of Governments (MWCOG) prepares a projection of the air quality expected on the following day. If, on any day an exceedance of the established ozone standard is expected the next day, MWCOG issues an alert to the companies and organizations making up the Clean Air Partnership, and the participating agencies and the news media. The information is conveyed to the public through a variety of sources including radio, TV, e-mail, web pages, newspapers and electronic highway signs.

To encourage travelers to avoid driving on these forecast Code Red Ozone Action Days (Code Red Days), fare collection is suspended on Northern Virginia bus services. These services include:

- WMATA – All Metrobus routes in Northern Virginia, including Falls Church GEORGE routes
- Fairfax Connector – Fairfax County
- DASH – City of Alexandria
- OmniRide and OmniLink – Potomac-Rappahannock Transportation Commission
- ART – Arlington County
- Loudoun County Transit – Loudoun County
- CUE – Fairfax City

The agencies operating the bus services and their contractors, upon receiving notification that the following day is forecast to be a Code Red Day, institute previously developed plans. Drivers when reporting for duty are informed that no fares are to be charged, the bus head signs are, in some cases, set to show “Code Red” or ‘Ozone Alert” or “Free Fare,” and bags are placed over the fareboxes.

The bus service providers are compensated for the associated loss of revenue through use of Federal Congestion Mitigation and Air Quality (CMAQ) funds. Compensation is based on the farebox revenues that would have been collected on a comparable “regular” day.

Program Evaluation

This evaluation project was instituted to determine the level of awareness of air quality Code Red Days and free bus fares, to estimate the emissions reductions resulting from ridership gains on forecasted Code Red Days, to assess the cost effectiveness of the

program for reducing ozone pollution and to recommend program enhancements to improve effectiveness and reliability.

Key tasks to be addressed by the evaluation were specified as:

- Determine the number of persons who ride transit on Free Fare Code Red Days, by individual provider/system.

- Determine the number of additional riders carried on free fare days in comparison to normal days.

- Understand the characteristics of free fare riders, in particular, those who would otherwise have traveled by some other mode, or who perhaps wouldn't have traveled at all.

- Ascertain the role and importance of offering fare-free service in program response/success, vs. how program utilization might change under a different protocol, e.g., if a nominal fare were charged.

- Recommend program enhancements to improve effectiveness and accountability, and enable continuous future monitoring by NVTC and the individual transit systems.

- Assess the overall public awareness and support of the program (in response to advertising, use, perceived value), along with suggestions for how awareness and support can be increased.

- Estimate the amount of emissions reduced by type of pollutant (VOCs, NOx and CO).

The information reported provides an initial evaluation of the effectiveness of the program. Due to the few forecast Code Red Days during the summer of 2003 it was not possible to collect data to describe the characteristics of the additional riders attracted on the Free Fare Days. The program analysis and assessment in the following sections of this report are based on data that were collected as part of the telephone survey of residents of the project area conducted during the summer of 2003 or were available from NVTC or the participating transit agencies. If this is deemed sufficient, no further analysis is required. However, continuation of the analysis with anticipated collection of on-board survey data on free fare days in the summer of 2004 would provide a much stronger position from which to either substantiate project funding requests or to initiate changes that will improve performance and effectiveness of the program.

Program to date

- Between 1999 and 2003, 29 Code Red Days have been forecasted.
- Total monetary outlay for bus fare reimbursements under the Free Fare program has been $1.5 million. During this same period, the bus systems report carrying 122,000

fewer riders on Code Red Days, or –4.5% against a base of 2.7 million riders who would have traveled on comparable days.
- Since there is no reason to believe that free fares should lead to lower ridership, the ridership data reported, especially for years prior to 2002, are of questionable reliability.

Years 2002 and 2003 only

- Over time, however, performance has progressively improved, especially for the two largest systems.
- Looking only at results for 2002 and 2003, there has been an increase in bus ridership on Code Red Days of 4.4% (72,000 bus trips against a normal base of 1.65 million).
- Total program funding outlay during this period was $671,000 (2002) and $140,000 (2003) = $ 811,000.
- The 72,000 added bus riders in 2002 and 2003 were gained at a cost of $11.26 per rider.
- In 2003, 41,000 additional riders were carried on Free Fare Days at a cost of $3.42 per added rider.

Emissions Reductions

- For the program in total, over its five-year 1999-2003 life span, there have been no net emission reduction benefits. This is because the program ridership data indicates a net loss of riders over this 5-year period.
- However, with the gradual improvement in ridership performance over time, by 2002 and 2003 net ridership gains are being demonstrated and, hence, emissions savings can be calculated.
- In 2002, with 12 forecasted Code Red Days, 32,000 new riders were added at a cost of $671,000. This resulted in an estimated 28,000 vehicle trips (cold starts) eliminated and 267,000 vehicle miles of travel. This translates to reductions of 0.218 tons of VOCs and 0.283 tons of NOx, for a total of 0.5 tons of ozone precursor pollutants. At a cost of $671,000 for the 12 forecast Code Red Days, this corresponds to a cost per ton of $1.34 million.
- Results for 2003 are better. For the two forecast Code Red Days in June 2003, a net ridership gain of 41,000 was realized. The estimated vehicle trip reduction associated with this ridership gain is 36,000, the VMT reduction is 446,000 and the calculated emissions reduction is 0.783 combined tons of VOCs and NOx. At a program cost of $140,000, this corresponds to a cost of $179,000 per ton. If only Metrobus is examined, its 33,000 ridership gain translates to 0.65 combined tons of emissions reduced at a cost of $57,000, or $88,000 per ton.
- The most direct comparison of the Code Red Fare Free Bus program with other regional efforts would be MWCOG's Commuter Connections program. This program, which consists of 6 separate elements, has also been operating since 1999. Its Annual Report reports daily VOC reductions of 1.179 tons and NOx

reductions of 2.378 tons. Against an annual budget of about $4.4 million, these reductions translate to a cost of $4,900 per combined ton. By element, costs range from a low of $2,085 for the Employer Outreach program to a high of $19,554 for the Commuter Operations Center. Of the remaining elements, the Telework Resource program operates at $5,342 per ton, Integrated Rideshare at $3,039 per ton, Employer Bicycle Outreach at $15,000 per ton, and Guarantee Ride Home at $16,997 per ton.

- As a way of gauging the effectiveness of the Free Fare Code Red Day strategy, its performance was compared with a national study of the Federal Congestion Mitigation Air Quality (CMAQ) program conducted by the Transportation Research Board (TRB) in 2001. In order to be comparable with the strategies presented in the TRB study, it was necessary to "weight" the pollutants to reflect that study's premise that NOx emissions were valued at 4 times the reductions of VOCs. Under this weighting assumption, the Northern Virginia Free Fare Code Red Day program delivers its 2003 emission reductions at the cost of $65,000 per ton. Metrobus, under the same parameters delivers reductions at $32,000 per ton. Among the 139 strategies, applied across the nation and reviewed by the TRB study, the Northern Virginia Code Red Free Fare Bus program would fall in the upper third of the cost-per-ton distribution, with about 65% of strategies costing less per ton. Metrobus' performance would fall about at the mid-point, with about half of the TRB strategies costing less.

  Strategies in the TRB national study that performed better as a group than the Northern Virginia Free Fare Code Red Day strategy, included Inspection & Maintenance programs (median of $1,900 per ton), Regional Ridesharing programs ($7,400/ton), Vanpool programs ($10,500/ton), Alternative Fuel Vehicles ($17,800/ton), Traffic Signalization ($20,100/ton), Conventional Transit Service Improvements ($24,600/ton), and Employer Trip Reduction programs ($22,700/ton). Strategies in the national study that performed the same or more poorly included Transit Capital Improvements/Vehicle Replacements ($66,400/ton), Bicycle/Pedestrian Facilities ($84,100/ton), New Transit Shuttles or Feeder Lines ($87,500/ton), Freeway Incident Management ($102,400/ton), Alternative Fuel Buses ($126,400/ton), HOV Lanes ($176,200/ton), and Telecommute/Telework ($251,800/ton).

- The direct effects of the free fare program on emission reductions on forecast Code Red Ozone Alert days result from shifting some trips from auto to bus. In addition, the media publicity of the Ozone Alert and the free bus fares increases general awareness of the availability of bus services. Benefits such as this are difficult to measure and quantify.

Program Awareness

Awareness of Code Red Ozone Alert and related terms, awareness of free bus fares on Code Red Days, and actions by commuters on Code Red Days were the subject of a telephone survey of 300 households.

- Residents of the survey area have a high recognition of the term Code Red Ozone Action Day and its meaning. Over half of the survey respondents provided a correct name unprompted and over 90% were familiar with the term after prompting. A high percent, over half, knew that actions to reduce auto use were desirable on these days. In a 2001 survey, MWCOG found that 90% of respondents were familiar with the terms.
- That bus fares are free on Code Red Days is less well known. Just over half of the respondents knew of the free fares. This was true both for those who perceived transit to be an option for their trip to work (47%) and those who did not. About 16% of the respondents indicated that they had used or had considered using the bus on a day projected to have poor air quality, but only 24% of this group (4% overall) reported the free bus fare as the reason for this decision.
- A surprisingly small number of commuters, 14%, said they did anything different on Code Red Days. The 2001 survey by MWCOG found that 17% reported doing something different. Those 14% in this survey (29 respondents) who did do something different were as likely to stay at home/indoors (8), or take carpools (7) as ride transit (7). This, too, is similar to the finding of the MWCOG survey.
- Of those persons who used or considered using the bus on Code Red Days, only 30% of commuters and 8% of non-commuters said that the free fare was their reason – as many or more said that their decision was based on wanting to reduce emissions or to avoid the heat.
- Asked directly whether getting free bus fares on Code Red Days made them consider using the bus, 40% of commuters said they considered using the bus, and 81% of them actually used it because it was free. Among non-commuters, 30% said the free fare made them consider using bus, but only 42% of these actually used it.
- Of those who used or considered using the bus on Code Red Days because of free fares, 73% said they would still use or consider using it if fares were only reduced by half. Commuters (69%) were somewhat less likely to still be interested at half fare than non-commuters (85%).

Recommended Action

Using the bus ridership data available from NVTC and estimates of travel patterns for commuters in Northern Virginia from the Metropolitan Washington Council of Governments, a preliminary evaluation of the effectiveness of the program has been developed. This evaluation reveals that that the free fare program, after a slow start, does seem to be attracting additional bus riders on forecast Code Red Days and, as a result, contributing to a small but significant reduction in the emissions on the days when exceedances of air quality standards are projected. The cost per ton of pollutant removed by these reductions is greater than some of the other measures already in place, but in line with the costs found in other programs and in other metropolitan areas.

There are signs that ridership data collection on the free fare days is improving. Reported passenger counts for the later days in 2002 and the days in 2003 seem more in line with the variation that would be expected. This may also be coupled with greater public awareness of both the program and the need for special actions on Ozone Alert Days.

The recommended action - continuation of the study through 2004 - would likely provide opportunities to determine if the trend toward reported ridership increases on free fare days continues and to collect on-board survey data so that characteristics of attracted riders can be determined. A program to assess the normal variation in daily ridership counts and to improve passenger counting on free fare days is also recommended.

Introduction

Air pollution continues to be a vexing problem in the Washington DC Metropolitan Area. In 2001, the regional transportation planning process was put on hold because federal clean air requirements could not be met. The following summer of 2002 brought nine Code Red Ozone Alert Days when children and the elderly were urged to stay indoors because of unhealthy air. High levels of ozone can react with lung tissue and cause coughing and chest pain, eye and throat irritation, breathing difficulties, and greater susceptibility to respiratory infection. While the region meets air quality standards (National Ambient Air Quality Standards, or NAAQS) for five of the six pollutants of concern, it continues to have ground-level ozone levels that exceed federal targets to protect human health and welfare.

Ground-level ozone, not to be confused with the beneficial ozone layer in the upper atmosphere that shields the earth from harmful ultraviolet radiation, is created when a mixture of air pollutants – mainly nitrogen oxides (NOx) and volatile organic compounds (VOCs) -- react with sunlight. About 30% to 40% of ozone-contributing pollutants in this region come from on-road mobile sources, namely cars, trucks and buses. While technological advances in engines and fuels are making individual vehicles cleaner, these trends are being offset by the sheer growth in vehicle travel and the accompanying increases in traffic congestion. Vehicle travel in this and most metropolitan regions across the country, as measured in vehicle miles of travel (VMT), has been outpacing the growth in population by a factor of 3 to 1 since the 1980s. Hence, any efforts to reduce ozone pollution must include strategies to manage emissions from motor vehicles.

Regional leaders have been working diligently to meet federal air pollution requirements since the Clean Air Act was amended in 1990, establishing concentration standards for each pollutant as well as a dates by which those standards must be achieved based on each area's current degree of nonattainment. Each region must have in place a State Implementation Plan that establishes emissions "budgets" for each contributing source, and a plan of action for achieving the established targets. Progress in achieving the SIP commitments are then monitored in several ways:

- By the number of times a standard is exceeded in a given year, as measured at strategically located air pollution monitoring sites.
- That mitigation strategies set forth in the plan are implemented as programmed.
- For transportation sources, that both the financially Constrained Long Range Plan (CLRP) and the six-year Transportation Improvement Program (TIP) "conform" with the schedule of attainment set forth in the SIP, i.e., that the proposed transportation investments will not detract from the region's attainment schedule.

Failure in either of these criteria can lead to a number of actions, from more stringent mitigation requirements being placed on the area to suspension of federal transportation funding for all or select projects.

The region's air quality attainment efforts are currently in flux. In February 2003, the region's nonattainment status was changed by the EPA from "moderate" to "severe"

because of issues related to progress in meeting its existing 1999-2003 attainment schedule. This change in status served to render the existing SIP invalid, and hence a new SIP is in development by the Metropolitan Washington Air Quality Committee (MWAQC) that will establish new emissions budgets for all sources. Before the current CLRP expires in January 2004, the EPA must approve a revised SIP for the region, a new CLRP and TIP must be demonstrated to conform with the new SIP, and these plans must then be approved by the Federal Highway Administration and the Federal Transit Administration. If the new CLRP is not approved by January 2004, federal funding for regional transportation projects may be jeopardized. Should this occur, the region will either have to program additional mitigation measures, or delete/postpone projects in its capital improvement program.

A more acute problem as the ultimate 2005 attainment deadline nears is the number of allowable "exceedances" at air quality monitoring sites. Between now and November 15, 2005, the region can experience no more than three exceedances of the ozone standard at any one monitoring site. Whereas the summer of 2003 produced only 2 days when the allowable concentration of ozone (124 ppm in any one hour) was exceeded, past years have yielded many more such days (12 in 2000 and 9 in 2002). Hence, it is extremely important to not only identify mitigation strategies that reduce mobile source emissions on a daily basis (for conformity purposes), but to have supplemental measures on hand to further reduce emissions on those Code Red Ozone Alert Days when a violation of the ozone standard is possible.

Transit and ridesharing are important strategies in the region's air quality management efforts. Many programs, which either improve transit or ridesharing services/options or encourage their use, have been implemented to provide regional travelers with daily alternatives to single-occupant vehicle use. However, special measures have also been developed for specific use on forecast Code Red Ozone Alert Days. One of these is the forecast Code Red Day free fare bus program managed by NVTC. If this program -- by offering a free ride on Northern Virginia buses -- can encourage a reasonable number of daily auto travelers to ride a bus on forecast Code Red Days, this savings in auto travel and pollution could be enough to help avert a critical exceedance of the ozone standard on that day. In addition, such a program may cause certain travelers to become regular bus (or transit) user by virtue of giving them experience in using transit.

The greatly increased regional air quality challenge coupled with the effects of contracting state and federal budgets has created a situation in which all programs and investments supported by public resources come under increased public scrutiny. Thus, for the forecast Code Red Day free bus fare program, it is necessary to have a firm understanding of how effective the program is in reducing vehicle emissions, both in terms of total emissions reduced and cost per ton as compared to other strategies.

The costs incurred by the free bus fare program are directly related to the number of Code Red Days forecast. The number of seasonal ozone exceedances is variable from year to year, and is difficult to predict since the condition depends on climate, weather and atmospheric conditions. While the number of forecast Code Red Days averaged only about four over previous years, there were 12 days in 2002 and only two during the summer of 2003. This causes a wide variation in program cost expectation and difficult budgeting challenges in a time of scarcity.

The evaluation reported here is not complete. Existing data coupled with a small sample telephone survey of households in Northern Virginia have been used to develop an understanding of the performance and component characteristics of the forecast Code Red Day free bus fare program. The proposed on-board survey, needed to obtain specific information to estimate the reduction in emissions attributable to the free fare program, could not be conducted. There simply were no forecast Code Red days during July and August 2002, the period when the surveys could have been conducted.

The purpose of this evaluation project was to determine the level of awareness of forecast air quality Code Red Days and free bus fares, estimate the emissions reductions resulting from ridership gains on forecast Code Red Days, and assess the cost effectiveness of the program for reducing ozone pollution.

Key tasks to be addressed by the evaluation were specified as:

- Determine the number of persons who ride transit on free fare forecast Code Red Days, by individual provider/system.

- Determine the number of additional riders carried on free fare days in comparison to normal days.

- Understand the characteristics of free fare riders, in particular, which of those would otherwise travel by some other mode, or who perhaps wouldn't have traveled at all.

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Program Description

Each day during the portion of the year in which high ozone levels may be expected to occur, the Metropolitan Washington Council of Governments (MWCOG) prepares a projection of the air quality expected on the following day. If, on any day an exceedance of the established ozone standard is expected the next day, MWCOG issues an alert to companies and organizations making up the Clean Air Partnership, the participating agencies and the news media. The information is conveyed to the public through a variety of sources including radio, TV, e-mail, web pages, newspapers and electronic highway signs.

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The bus service providers are compensated for the associated loss of revenue through use of Federal Congestion Mitigation and Air Quality (CMAQ). Compensation is based on the farebox revenues that would have been collected on a comparable “regular” day.

Each agency reports to NVTC the following information for the forecast “Code Red” Days and for the same day of the week for the three weeks preceding the forecast Code Red Day.

- Farebox revenue
- Counted boarding passengers

Payment to the operating agency is the difference between the revenue received on the forecast Code Red Day and the average revenue for the same day in the three preceding weeks. If one of the days in the three preceding weeks was atypical (e.g., a holiday) then data from the fourth preceding week is used.

The participating agencies also report to NVTC the ridership (passenger boardings) on the free fare day and on each of the three days for which revenues are reported. Reimbursement to the transit agencies for lost revenue is based solely on the difference

between “average” farebox revenue and farebox revenue of the free fare day. Passenger boardings are reported only for statistical purposes and are not used to determine revenue loss.

Approach to Study

The primary objective of the program is to reduce automobile generated emissions. The standard measure used to assess the effectiveness of such actions is cost per ton of pollutants reduced. To develop this measure requires information related to:

- The number of travelers who use transit on a forecast Code Red Day who would not typically use transit.
- The proportion of these incremental riders who would typically be auto drivers.
- The proportion of these incremental riders who chose to use transit because of the free bus fare.
- The trip pattern (origin and destination) of these incremental riders.
- Whether the incremental riders walk to the bus or park-and-ride.

With these data in hand, the reduction in emitted pollutants attributable to the free bus fares can be estimated by applying emissions factors to the associated reduction in vehicle trips and vehicle miles of travel (VMT). The cost of the program is known from NVTC accounting records. The cost per ton of pollutants reduced can then be directly calculated.

A second objective of this study is assessment of public awareness of both the importance and meaning of the Code Red Ozone Alert Days and the fact that bus fares are free on such days.

Change in Travel on Free Fare Days

The first portion of the program assessment effort is determination of the changes in travel and travel behavior on free fare days. Determining the extent of these changes was based on several sources including:

- Permanent station traffic counts from the Virginia Department of Transportation
- Counts of boardings at selected Metrorail stations in Northern Virginia that are the connecting points for multiple bus routes
- Counted bus boardings as reported to NVTC by the participating operating agencies

Bus Rider Characteristics

The quantification of the change in automobile activity, primarily cold-starts and vehicle-miles-of-travel, resulting from the change in travel on free fare days was to be based on information collected in rider surveys conducted on-board a sample of buses on free fare days. A survey, discussed in greater detail in a later section, was designed and reviewed by the project committee. Although there were two forecast Code Red Ozone Alert Days in June 2003, both occurred before the on-board survey form was approved

and printed. The data that would have been obtained from these surveys are not available for use in program analysis and evaluation. If the project is continued, the surveys will be attempted in summer of 2004 and the data, if collected, used in follow-up evaluation.

Markets and Awareness

Analysis of awareness of the Code Red Ozone Alerts and of the related free bus fares was not limited to the bus riding population but rather extended to all residents of the jurisdictions participating in the program. To gather data from such a large and dispersed group a telephone survey was designed. This was administered in mid-August 2003. Questions related to modes of travel used for commuting, knowledge of the terms Code Red or Ozone Alert, appropriate actions on forecast Code Red Days, sources of information about Code Red Day forecasts, knowledge of the free bus fares, and use of transit with and without free fares.

Likely Emission Reductions

The quantity of pollutants emitted by an automobile engine depends on many factors including the time since the vehicle was last started, the duration of vehicle operation, the speed at which the vehicle is operated and the miles traveled. Data from the on-board survey were to be used to gauge these factors for trips by those attracted to transit by the free fare. Lacking the on-board data, selected data from other sources (e.g. MWCOG travel surveys or travel models, default emission factors, etc.) have been used to develop an estimate of resultant emissions reductions.

Program Assessment

The emission reduction, in tons, is divided by the program cost as recorded by NVTC to obtain a cost per ton reduced. This is then compared to the cost per ton for reductions achieved through other programs as reported in Transportation Research Board Special Report 264, "*The Congestion Mitigation and Air Quality Improvement Program: Assessing 10 Yeas of Experience,"* published in 2002.

Analysis

Current and historic data related to program costs in the years 1999 through 2003 and reported bus ridership on each system on forecast Code Red Days during the same period were assembled during the summer of 2003. As noted, the intended on-board survey was not conducted, but the telephone survey was administered to gather information about public awareness of the programs. The analysis reported below is based on data derived from these sources.

Markets and Awareness

Telephone Survey

The primary purpose of the telephone survey was to probe the awareness of residents of the affected Northern Virginia jurisdictions of the Code Red Ozone Alert program and, in particular, of the offer of free bus fares on days forecast to be Code Red. The sample size, 300 completed interviews, was selected to be large enough to answer this question for the entire study area with reasonable statistical confidence (+/- 3% at the 90% confidence level). The survey was also used to gather information about resident's current travel patterns, their responses to forecast Code Red Days and the sources of information about bad air days. Because there were fewer responses from residents of individual jurisdictions, there is a lower level of statistical confidence in the reported responses at that level. **Many of the following tables present data by jurisdiction. These are for illustrative purposes. However, because of the reduced sample size, these implied relationships may not be statistically significant.**

Questionnaire

The telephone survey was conducted as an interview, rather than a self-administered questionnaire. The interview script is contained in Appendix C.

Survey Administration

A local firm that has over twenty years of experience in gathering survey information conducted the survey by telephone. Staff was located in the metropolitan Washington area so they had an understanding of the local transportation issues and knowledge of area public transit systems. The survey was administered to a sample of randomly selected telephone numbers in Arlington, Alexandria, Falls Church, Fairfax County, Loudoun County, Manassas, Manassas Park and Prince William County. Phone numbers assigned to business use, fax machines, dedicated computer connections and cell phones were excluded. Calls were placed from 6 PM to 9 PM between August 20 and August 25, 2003. Three hundred completed responses were obtained.

Sample Characteristics

The survey sample consists of 300 individuals including both commuters and non-commuters from seven jurisdictions. As shown in Table 1, there are 212 commuters and 88 non-commuters in the database, representing Arlington, Fairfax, Loudoun and Prince William Counties, and the cities of Alexandria, Falls Church and Manassas.

Table 1 – Sample of Commuters and Non-commuters by Jurisdiction

Jurisdiction	Commute to Work/School	Do Not Commute	All
Arlington County	20	17	37
Fairfax County	109	37	146
Loudoun County	21	11	32
Pr. William County	46	12	58
Alexandria	13	6	19
Falls Church		3	3
Manassas	3	2	5
Total	212	88	300

Modal Use Patterns of Commuters

Commuters were studied in somewhat greater detail in this survey, because of the presumed emphasis of the Free Fare program in reducing peak period vehicle use and emissions. Table 2 provides relevant modal use characteristics of the commuter sample.

Each respondent was asked to indicate all of the modes that he or she used for commuting to work or school. As seen in Table 2, this suggests that many commuters use more than one mode for commuting – either by mixing modes on the same trip, or using some mode as their primary choice with one or more backup modes used on other days. Clearly, the great majority of commuters drive alone, 60%, while 13% ride Metrorail, 8% travel as auto passengers and pedestrians, 5% travel by bus, and 3% each by VRE and bicycle.

Table 2 – Reported Commute Modes During a Typical Week, by Jurisdiction

Jurisdiction	Drive Alone	Auto Passenger	Metro-rail	VRE	Bus	Walk	Bike	All	Total Commuters
Arlington County	16	4	7		2	4	1	34	20
Fairfax County	99	11	26	5	11	10	3	165	109
Loudoun County	20	3	2		1	1	1	28	21
Pr. William County	42	5	1	3	1	5	1	58	46
Alexandria	10	3	5		2	5	2	27	13
Falls Church									
Manassas	2		1	1				4	3
Total	189	26	42	9	17	25	8	316	212
Percent	60%	8%	13%	3%	5%	8%	3%	100%	

Additional information from the respondent was used to discern which of the various modes cited was the "Primary Mode;" the mode used most often. Table 3 indicates that when this is done, the percentage of drive alone is substantially higher (82% vs. 60% above), while percentages of all other modes decline. Thus while 21% of all commuters mention transit (Metrorail, VRE and bus), only 13% of those surveyed use transit as their primary commute mode on an average day. Bus as a primary mode falls to only 2% (vs. 5% above), most probably because of its role as a feeder to rail transit. Only 2 respondents had walk and 1 had bike as their primary mode.

Table 3 – Primary Commute Mode (average day), by Jurisdiction

Jurisdiction	Drive Alone	Auto Passenger	Metro-rail	VRE	Bus	Walk	Bike	All
Arlington County	15		4		1			20
Fairfax County	91	1	12	2	2	1		109
Loudoun County	18	2	1					21
Prince William	40	3	1	1	1			46
Alexandria	8	1	2			1	1	13
Manassas	2			1				3
Total	174	7	20	4	4	2	1	212
Percent	82%	3%	9%	2%	2%	1%	<1%	100%

Table 4 is provided simply to show the cross-relationship between Primary Mode and other modes that were mentioned. Clearly, many commuters whose primary mode is Metrorail or VRE also use other modes, especially drive alone, bus, walk and bike for access. However, a substantial number of auto drivers also indicate use of auto passenger, transit, and even bike and walk as part of their trip or as alternatives on one ore more days per week.

Table 4 – Primary Commute Mode vs. Other Modes Used

		Other Modes Used						
Primary Mode	Mode Used on Typical Day	Drive Alone	Auto Passenger	Metrorail	VRE	Bus	Walk	Bike
Drive Alone	174		12	17	3	6	12	3
Auto Passenger	7	1					1	
Metrorail	20	8	5		2	8	8	4
VRE	4	2	1	2				
Bus	4	1	1	2			2	
Walk	2	2		1				
Bike	1	1						
Total	212	15	19	22	5	14	23	7

For many commuters, an issue in using transit is in its availability for their particular trip. Table 5 indicates the percentage of commuters by each jurisdiction who indicate that they have transit available for their trip to work or school. Overall, about the same

percentage of respondents say that transit is available for their commute (47%) as say that it is not (47%), while 6% don't know or are not sure. Clearly, the jurisdictions where the perceived availability is highest are the most urban of the areas -- Alexandria (92%) and Arlington (75%) -- while Fairfax is above average at 52%. In the remaining jurisdictions, perceived availability ranges from 15% to 33%.

Table 5 –Public Transportation Available to Place of Employment

	Public Transportation Available						
Jurisdiction	**Yes**	Percent	**No**	Percent	**Don't Know**	Percent	**All**
Arlington County	15	75%	4	20%	1	5%	20
Fairfax County	57	52%	43	39%	9	8%	109
Loudoun County	7	33%	14	67%		0%	21
Pr. William Co.	7	15%	36	78%	3	7%	46
Alexandria	12	92%	1	8%		0%	13
Manassas	1	33%	2	67%		0%	3
Total	99	47%	100	47%	13	6%	212

This availability clearly shows up in the modal use patterns, with Alexandria, Arlington, and Fairfax having the highest rates of transit use (Table 3). Table 6 shows this in more detail. Only 38% of those commuters whose primary mode is driving alone perceive that they have transit available, while 100% of those using Metrorail or VRE confirm transit availability.

Table 6 – Primary Mode vs. whether Public Transportation Available to Place of Work/School

	Public Transportation Available						
Primary Mode	**Yes**	**Percent**	**No**	**Percent**	**Don't Know**	**Percent**	**All**
Drive Alone	65	38%	97	56%	12	7%	174
Auto Passenger	5	71%	1	14%	1	14%	7
Metrorail	20	100%		0%		0%	20
VRE	4	100%		0%		0%	4
Bus	3	75%	1	25%		0%	4
Walk	1	50%	1	50%		0%	2
Bike	1	100%		0%		0%	1
Total	99	47%	100	47%	13	6%	212

While only three respondents among the commuter sample, or 1.4%, list bus as their major mode, 18 commuters use bus at least 1 day per week. This is shown in

Table 7, which indicates that seven commuters use bus less than every day, suggesting that it may be an alternative, while 10 use it 5 days or more, suggesting that it plays an important role as a support mode in accessing Metro or VRE. This support role helps increase the potential effectiveness of the free fare program, in that a reasonable number of commuters may not be able to use bus as their primary mode, but can make use of it to connect with the regional transit system instead of driving or being driven.

Table 7 – Number Days Use Bus, by Jurisdiction

Jurisdiction	0	1	2	3	4	5	7	All
Arlington County	18	1					1	20
Fairfax County	98	2	1	2	1	5		109
Loudoun County	20					1		21
Pr. William Co.	45					1		46
Alexandria	11					2		13
Manassas	3							3
Total	195	3	1	2	1	9	1	212

The distribution of these 18 surveyed bus riders among the individual Northern Virginia systems that are participating in the Free Fare program is as follows:

Table 8 – Bus System Used by 18 Bus Riders Found in Survey

Metrobus	7
Fairfax Connector	7
PRTC	1
Alexandria	3
Arlington	0
CUE	0
Loudoun	0

The failure to find riders of ART, CUE or Loudoun Transit in the survey is a result of the relatively small sample size. The survey was designed to measure awareness of free fares and not bus ridership by system.

Code Red Day Awareness

Question 5 of the survey asked both commuters and non-commuters if they knew the terminology used by the Metropolitan Washington Council of Governments in declaring "a day when ozone levels were high and air quality poor." Table 9 reveals that 59% of commuters, and 46% of non-commuters, were able to correctly identify the first two choices – Code Red Days or Ozone Action Days – which is a vital precursor for knowledge and use of the forecast Code Red Day free bus fare program. However, perhaps more significantly, 34% of all commuters and 48% of non-commuters did not know the terminology used, and these percentages are even higher if the answers given reflect a lack of knowledge about what an ozone alert is.

Table 9 – Know What MWCOG Calls Days with Bad Air Quality (Qu. 5)

	Code Red Days	Ozone Action Days	Bad Air Day or Alert	Other Name	Don't Know	All	Pct. Don't Know	Pct. Know
Commuter	116	10	6	7	73	212	34%	59%
Non-Commuter	40	3	2	1	42	88	48%	49%
Total	156	13	8	8	115	300		
Percent	52%	4%	3%	3%	38%	100%		

This awareness may also be linked with jurisdiction. The data presented in Table 10 appear to show that respondents living in Alexandria (53%) and Arlington (49%) were much more likely to not know the meaning of Code Red than residents of the other areas (average 33-40% do not know). This finding is a bit surprising in that these are the most urban and transit oriented jurisdictions in the sample (highest transit availability and use), but income and education may be factors here. However, as shown in further analysis (Table 21) in these jurisdictions those who know the terminology are also aware of the free fare program. This suggests that a greater effort to inform the public in all areas about the air quality alert program could reap the benefit of even greater transit use during forecast Code Red periods.

Table 10 – Know What MWCOG Calls Bad Air Days, by Jurisdiction

Jurisdiction	Code Red Days	Ozone Action Days	Bad Air Day or Alert	Other Name	Don't Know	All	Pct. Don't Know
Arlington County	11	4	2	2	18	37	49%
Fairfax County	84	4	2	3	53	146	36%
Loudoun County	20	1			11	32	34%
Pr. William Co.	32	2	3	1	20	58	34%
Alexandria	5	2	1	1	10	19	53%
Falls Church	1			1	1	3	33%
Manassas	3				2	5	40%
Total	156	13	8	8	115	300	
Percent	52%	4%	3%	3%	38%	100%	

Indeed, if one looks at level of awareness by primary commute mode as in Table 11, it is interesting to note that the highest rates of “not knowing” the meaning of Code Red are among Metrorail (45%) and VRE (75%) users.

Table 11 – Know What MWCOG Calls Bad Air Days, by Primary Commute Mode

Primary Mode	Code Red Days	Ozone Action Days	Bad Air Day or Alert	Other Name	Don't Know	All	Pct. Don't Know
Drive Alone	96	9	6	4	59	174	34%
Auto Passenger	5			1	1	7	14%
Metrorail	9	1		1	9	20	45%
VRE	1				3	4	75%
Bus	4					4	0%
Walk	1				1	2	50%
Bike				1		1	0%
Total	116	10	6	7	73	212	
Percent	55%	5%	2%	3%	35%	100%	

For those who did not correctly identify the terms "Code Red Day" or "Ozone Action Day" in Question 5, Question 6 subsequently asked verbatim if they had ever heard of these terms. Using this approach, those who did not know the correct answer in Question 5 suggested very high recognition of the concept when mentioned by name. As seen in Table 12, 84% of commuters and 67% of non-commuters who previously "didn't know" claimed to recognize these terms. Similarly, much higher levels of recognition were claimed by jurisdiction (Table 13) and by primary mode user (Table 14).

Table 12 – Ever Heard of Term "Code *or Ozone Action Day in Qu. 5)*

	Yes	Percent	No	Percent	Don't Know	Percent	All
Commuter	72	84%	10	12%	4	5%	86
Non-Commuter	30	67%	12	27%	3	7%	45
Total	102	78%	22	17%	7	5%	131

Table 13 -- Ever Heard of Term "Code Red Day" or "Ozone Action Day" (Qu. 6), by Jurisdiction *(persons who did not answer Code Red Day or Ozone Action Day in Qu. 5)*

Jurisdiction	Yes	Percent	No	Percent	Don't Know	Percent	All
Arlington County	17	77%	4	18%	1	5%	22
Fairfax County	46	79%	8	14%	4	7%	58
Loudoun County	10	91%	1	9%		0%	11
Pr. William Co.	21	88%	2	8%	1	4%	24
Alexandria	6	50%	5	42%	1	8%	12
Falls Church	1	50%	1	50%		0%	2
Manassas	1	50%	1	50%		0%	2
Total	102	78%	22	17%	7	5%	131

Table 14 -- Ever Heard of Term "Code Red Day" or "Ozone Action Day" (Qu. 6), by Primary Commute Mode *(commuters who did not answer Code Red Day or Ozone Action Day in Qu. 5)*

Primary Mode	Yes	Percent	No	Percent	Don't Know	Percent	All
Drive Alone	60	88%	5	7%	3	4%	68
Auto Passenger	2	100%		0%		0%	2
Metrorail	7	70%	2	20%	1	10%	10
VRE	2	67%	1	33%		0%	3
Bus					4	100%	4
Walk			1	100%			1
Bike			1	100%			1
Total	71	80%	10	11%	8	9%	89

It is possible that the structure of Question 5 made a correct answer difficult. The question referred to the Metropolitan Washington Council of Governments. Respondents not familiar with MWCOG may have been distracted by this reference. There is still doubt as to how many of the "knowledgeable" respondents actually knew the real meaning of the Code Red Day term. These individuals were asked to give a verbal description of what they thought the term Code Red or Ozone Action Day meant to them, and the answers are summarized in Table 15. After studying and categorizing these responses (many of which had multiple characteristics entered), only 39% stated that a Code Red Day declaration represented a condition of poor air quality so bad that activities should be altered. Small but important percentages knew that you should curtail driving (21%), gasoline fill ups (9%), and lawn mowing (8%). About 9% believed that you should take transit or carpools on these days, and 4% even knew that buses were free on these days. About 30% suggested that you should avoid outdoor activity, and that small children, the elderly and persons with breathing problems should stay indoors. However, in many cases it was not clear from the response whether the perception was about air "quality," or simply hot, humid weather. Many respondents associated a Code Red Days with getting plenty of fluids, staying out of the sun, and not overexerting themselves.

Table 15 – What Does "Code Red Day" Mean to You (Qu. 6A) *[transcription of open-ended responses]*

Very poor air quality, health concern	117	39%
Special problems for children, elderly, breathing impaired	38	13%
Stay indoors, avoid outdoor activity	90	30%
Don't drive, cut down on driving	62	21%
Don't fuel vehicles before sundown	27	9%
Don't mow lawn or use gasoline engines	23	8%
Take public transit or carpool	26	9%
Buses are free	11	4%
Hot, humid weather -- heat stroke risk	53	18%
Change behavior (for some reason?)	3	1%
Don't know	15	5%

The general conclusion from these findings is that a substantial percentage of the population is not well informed about pollution alerts, their causes and impacts, and what remedies exist and why they are useful.

Forecast Bad Air Quality Day Information Sources

Both commuters and non-commuters were asked to identify the sources by which they received forecast bad air quality alert information. Responses are summarized in Table 16. Clearly, TV (65%) and Radio (57%) were the most frequently mentioned sources, with Newspaper (14%) and Electronic Highway Message Sign (10%) being the next most common. Commuters were more likely to have cited Radio (64%) and Highway Sign (13%) than non-commuters, while TV (85%) and Newspaper (22%) were the most popular sources for non-commuters. TV, Radio and Newspaper are also the major sources across individual jurisdictions. Fairfax and Prince William residents also seem to be particularly able to take advantage of the Electronic Message Signs.

Table 16 –Source of Information on Bad Air Quality Alerts (Qu. 11), by Jurisdiction

Information Source	Arling-ton County	Fairfax County	Loudoun County	Pr. William County	Alex-andria	Falls Church	Manassas	All Juris-dictions	Pct. Of Respon-dents
TV	**23**	**102**	**21**	**35**	**9**	**2**	**4**	**196**	**65%**
Commuters	10	71	11	24	3		2	121	57%
Non-Commuters	13	31	10	11	6	2	2	75	85%
Radio	**16**	**82**	**21**	**41**	**8**	**2**	**1**	**171**	**57%**
Commuters	11	68	15	33	7		1	135	64%
Non-Commuters	5	14	6	8	1	2		36	41%
Newspaper	**5**	**20**	**5**	**9**	**4**			**43**	**14%**
Commuters	3	11	2	6	2			24	11%
Non-Commuters	2	9	3	3	2			19	22%
Elect. Highway Sign	**3**	**11**	**4**	**10**	**2**		**1**	**31**	**10%**
Commuters	2	10	3	9	2		1	27	13%
Non-Commuters	1	1	1	1				4	5%
Website	**2**	**10**	**5**	**6**	**4**			**27**	**9%**
Commuters		7	3	4	4			18	8%
Non-Commuters	2	3	2					7	8%
Weather Report	**3**	**9**	**1**	**2**	**2**			**17**	**6%**
Commuters		8	1	1	2			12	6%
Non-Commuters	3	1		1				5	6%
Bus Display	**2**	**4**		**3**	**3**			**12**	**4%**
Commuters	1	3		3	3			10	5%
Non-Commuters	1	1						2	2%
Email	**1**	**5**	**2**	**1**			**1**	**10**	**3%**
Commuters		5	2	1				8	4%
Non-Commuters	1						1	2	2%
Employer Alert		**2**	**1**	**2**	**1**			**6**	**2%**
Commuters		2	1	2	1			6	3%
Non-Commuters								0	0%
I Can Feel it	**1**	**2**			**1**			**4**	**1%**
Commuters	1	2			1			4	2%
Non-Commuters								0	0%
Other									
Commuters	1 (sign flashing on I-66)								
Non-Commuters									

Bad Air Quality Day Behavior Changes

Commuters were asked if they did anything different on bad air quality days (Question 4). Interestingly, only about 14% said they did something different, with the highest percentage being in Arlington (25%) and the lowest in Loudoun County (2%), Alexandria (1%), and Manassas (0%).

Table 17 – Do Anything Different on Bad Air Quality Days, by Jurisdiction (commuters)

Jurisdiction	Yes	Percent	No	Percent	Don't Know	Percent	All
Arlington County	5	25%	14	70%	1	5%	20
Fairfax County	14	13%	94	86%	1	1%	109
Loudoun County	2	10%	19	90%		0%	21
Pr. William Co.	7	15%	37	80%	2	4%	46
Alexandria	1	8%	12	92%		0%	13
Manassas		0%	3	100%		0%	3
Total	29	14%	179	84%	4	2%	212

Asked what they did differently, Table 18 indicates that those who did change their behavior on bad air quality days mainly stayed indoors, or if they traveled, took transit or carpooled. Prince William and Loudoun respondents were most likely to carpool, while the Fairfax and Alexandria respondents were the most likely to take transit.

Table 18 – What Do Different on Bad Air Quality Days, by Jurisdiction (sample of 29)

Jurisdiction	Take Carpool	Take Transit	Tele-commute	Stay Indoors	Other	All
Arlington County		1	2	2		5
Fairfax County	1	3	1	4	5	14
Loudoun County	2					2
Pr. William Co.	4	2	1	2		9
Alexandria		1				1
Manassas						0
Total	7	7	4	8	5	31*

* Note that total responses of 31 exceeds number of respondents because of multiple responses.

Table 19 and Table 20 pose the same questions in relation to Primary Mode used for commuting. Conspicuously, commuters who drive alone were the least likely to do anything different on bad air quality days, registering only 13%, while 29% of auto passengers indicated a change in behavior. Meanwhile, only 20% of Metrorail users and 0% of the VRE and Bus users indicated that they did anything differently on forecast bad air quality days, although one would hope that this is because they would continue riding transit on forecast Code Red Days. Table 20 shows that of the 23 drive alone commuters who said they changed routine, only 3 used carpools and 2 used transit, while the majority stayed home (6) or did something else (5). The Metrorail users who changed mainly indicated that they took transit (presumably of some other type) or carpooled, just as the 3 auto passengers said that they did on these days.

Table 19 – Do Anything Different on Bad Air Quality Days, by Primary Mode

Primary Mode	Yes	Percent	No	Percent	Don't Know	Percent	All
Drive Alone	23	13%	147	84%	4	2%	174
Auto Passenger	2	29%	5	71%		0%	7
Metrorail	4	20%	16	80%		0%	20
VRE		0%	4	100%		0%	4
Bus		0%	4	100%		0%	4
Walk		0%	2	100%		0%	2
Bike		0%	1	100%		0%	1
Total	29	14%	179	84%	4	2%	212

Table 20 – What Do Different on Bad Air Quality Days, by Primary Mode (sample of 29)

Major Mode	Take Carpool	Take Transit	Telecommute	Stay Indoors	Other	All
Drive Alone	3	4	2	8	9	26
Auto Passenger	2*	1				3
Metrorail	2	2	2			6
VRE						0
Bus						0
Walk						0
Bike						0
Total	7	7	4	8	9	35

* Counterintuitive response may be due to changing carpool arrangements, e.g., traveling in a carpool with more or fewer occupants.

Awareness of Free Fare Program

Both commuters and non-commuters were asked if they were aware that buses were free on forecast Code Red Days (Question 8). Responses tabulated in Table 21 indicate that only 54% of commuters and 44% of non-commuters were aware of this program. Highest rates of awareness for commuters were in Alexandria (62%) and Arlington (60%), while for non-commuters it was Arlington (53%) and Prince William (58%). This finding somewhat contradicts the earlier observation in Table 10 that Arlington and Alexandria had among the lowest awareness of the meaning of Code Red terminology. It is also somewhat surprising that the knowledge among non-commuters is not higher in those areas which are well served by bus transit – Arlington and especially Alexandria – while it appears to be higher in Prince William. It must be remembered, however, that the small sample sizes make it difficult to rely too heavily on apparent differences among jurisdictions.

Table 21 – Aware Bus is Free on Forecast Code Red Days (Qu. 8), by Jurisdiction

	Arlington County	Fairfax County	Loudoun County	Pr. William County	Alex-andria	Falls Church	Manassas	All Juris-dictions
Commuters Aware	12	60	9	25	8		1	115
Total Commuter Respondents	18	102	20	45	13		3	201
Pct. Aware	67%	59%	45%	56%	62%		33%	57%
Non-Commuters Aware	9	14	4	7	1	2	2	39
Total Non-Commuter Respondents	17	36	11	12	6	3	2	87
Pct. Aware	53%	39%	36%	58%	17%	67%	100%	45%
All Aware	21	74	13	32	9	2	3	154
Total Respondents	35	138	31	57	19	3	5	288
Pct. Aware	60%	54%	42%	56%	47%	67%	60%	53%

Note: Survey respondents who considered taking the bus and claimed free fare as a reason (12 persons) are not included in this table.

Awareness of free bus fares among commuters by primary mode is shown in Table 22, and indicates that bus (75%) and Metrorail (60%) users are among the best informed, while auto passengers (57%) and drive alone commuters (54%) are somewhat less knowledgeable. Only one-fourth (25%) of VRE users were aware of the free bus fares.

Table 22 – Aware Bus Is Free on Forecast Code Red Days (Qu. 8), by Primary Commute Mode

Primary Mode	Aware	Not Aware	Blank	Total	Percent Aware
Drive Alone	93	74	7	174	54%
Auto Passenger	4	2	1	7	57%
Metrorail	12	6	2	20	60%
VRE	1	3		4	25%
Bus	3		1	4	75%
Walk	2			2	100%
Bike		1		1	0%
Total	115	86	11	212	55%

Consider Using Bus on Forecast Code Red Days

Question 7 of the survey asked both commuter and non-commuter respondents whether they had ever used, or considered using, the bus on days when the local air quality was predicted to be poor, for trips that they would not ordinarily make by bus. Table 23 shows the responses for commuters and non-commuters by jurisdiction. Overall, only 17% of commuters and 14% of non-commuters indicated that they had used or considered using the bus on forecast Code Red Days. The highest rates among commuters were in Arlington (35%) and Fairfax (20%), while the highest rates among non-commuters were in Prince William (25%) and Falls Church (33%). These findings are somewhat surprising, since Prince William is not a particularly transit oriented area for non-commuters, while Alexandria is.

Table 23 – Consider Using Bus on Forecast Code Red Days (Qu. 7), by Jurisdiction

	Arlington County	Fairfax County	Loudoun County	Pr. William County	Alex-andria	Falls Church	Manassas	All Juris-dictions
Commuters who would consider	7	22	3	4	1			37
Total Commuter Respondents	20	109	21	46	13		3	212
Pct. Consider	35%	20%	14%	9%	8%		0%	17%
Non-Commuters who would consider	3	4		3	1	1		12
Total Non-Commuter Respondents	17	37	11	12	6	3	2	88
Pct. Consider	18%	11%	0%	25%	17%	33%	0%	14%
All	10	26	3	7	2	1	0	49
Total Respondents	37	146	32	58	19	3	5	300
Pct. Consider	27%	18%	9%	12%	11%	33%	0%	16%

Among primary mode users (commuters only), Table 24 shows that neither auto drivers (16%), auto passengers (14%), nor VRE users (0%) were likely to use the bus on forecast Code Red Days. Meanwhile Metrorail users (30%) and bus users (50%) were favorably inclined, although it is unclear whether their reference in this question is in using bus as a substitute for their commute trip, or for other trips that they currently do not make by bus.

Table 24 – Consider Using Bus on Code Red Days (Qu. 7), by Primary Commute Mode

Primary Mode	Consider	Not Consider	Blank	Total	Percent Consider
Drive Alone	28	141	5	174	16%
Auto Passenger	1	6		7	14%
Metrorail	6	12	2	20	30%
VRE		4		4	0%
Bus	2	2		4	50%
Walk		2		2	0%
Bike		1		1	0%
Total	37	168	7	212	18%

Traveler's proclivity to take the bus on forecast Code Red Days was further probed in relation to two relevant questions – whether public mass transit (not just bus) was available for their commute to work or school, and the number of motor vehicles owned by their household. Table 25 shows the responses of commuters in relation to transit availability for their commute trip. Note that approximately half of the commuter sample believes that it has transit available for its trip to work/school (99) and half believes it does not (100). Of those who perceive that transit is available, 24% said they would consider using the bus on forecast Code Red Days (although the availability of bus for this trip is not clear – Metrorail or VRE may be the superior or only option). For those who did not perceive transit as an available option for their commute trip, 13% still said they would consider using the bus, although one must conclude that the interpretation of this response is that they would use the bus for something other than commuting. Non-commuters are shown in Table 25 only for comparison on whether they would consider using bus on forecast Code Red Days if there were a bus available, since the issue of transit availability to work/school was not relevant to their choice.

Table 25 – Consider Using Bus on Forecast Code Red Days (Qu. 7), by Transit Availability

	Consider	Not Consider	Blank	Total	Percent Consider
Commuter					
Transit Available	24	72	3	99	24%
Not Available	13	83	4	100	13%
Non Commuter	12	75	1	88	14%
Transit Available	NA	NA	NA	NA	NA
Not Available	NA	NA	NA	NA	NA
Total	49	230	8	287	17%

Table 26 probes willingness to consider using the bus in relation to household vehicle ownership, with the hypothesis being that more vehicles would lead to less interest in using transit (vehicle ownership also reflects different locational and economic characteristics of those households). Indeed, for commuters the likelihood of considering bus use declines with number of vehicles owned, from 100% of those in autoless households (only 1 observation), 22% of those in 1 vehicle households, 19% of those in 2 vehicle households, and 9% in 3 vehicle households. A somewhat surprising result occurs in the 4-or-greater vehicles category, as the percent willing to consider bus

goes back up to 15%, exceeding that for the 3 vehicle category. For non-commuters, the trend is *exactly the opposite*. The more vehicles owned, the more likely the respondent is to consider using bus, with none of the 4 zero vehicle households indicating a willingness to use bus! The reader is cautioned to observe the small sample size associated with some of these relationships, however, before giving any confidence to them as valid trends. Also, one must also factor in the size of the household and number of drivers creating a demand for household vehicles before accepting number of vehicles as a proper measure of vehicle availability.

Table 26 – Consider Using Bus on Forecast Code Red Days (Qu. 7), by Number of Household Vehicles

Number Vehicles	Consider	Not Consider	Blank	Total	Percent Consider
Commuter					
0	1			1	100%
1	10	34	2	46	22%
2	18	73	3	94	19%
3	4	39	2	45	9%
4+	4	22		26	15%
Non-Commuter					
0		4		4	0%
1	5	31	1	37	14%
2	5	25		30	17%
3	2	7		9	22%
4+		8		8	0%
All					
0	1	4		5	20%
1	15	65	3	83	18%
2	23	98	3	124	19%
3	6	46	2	54	11%
4+	4	30		34	12%

Another check on the reasoning of respondents with regard to being willing to use the bus is to compare what they said they do different on bad air days (Question 4, asked only of commuters) with their willingness to consider bus. Results are shown in Table 27. Forty-one percent of those who said they do something different on bad air days indicated that they have used or considered using the bus, and 71% of those who said they take transit on poor air quality days say they used or considered using the bus. Relatively small proportions of those who carpooled (14%) or who stayed indoors (25%) considered bus, although a surprisingly high percent of those who telecommute (75%) indicated a consideration of bus.

Table 27 – Consider Using Bus on Forecast Code Red Days (Qu. 7), by Consider Doing Something Different (Qu. 4) *[commuters only asked Qu. 4]*

	Consider Using Bus	Not Consider Using Bus	Total	Percent Consider
Do something Different on poor air quality days?	12	17	29	41%
Carpool	1	6	7	14%
Take transit	5	2	7	71%
Telecommute	3	1	4	75%
Stay indoors	2	6	8	25%
Total	23	32	55	42%

Importance of Free Fare

Two key considerations in evaluating the effectiveness of offering free bus fares on forecast Code Red Days are (1) determining the extent to which people are aware that the program is offered, and (2) the extent to which that knowledge influences their decision to use or consider using the bus. A series of linked questions were asked in the survey to probe these factors and lead to a better of understanding of whether free bus fares are important, and the degree of success that has been realized in the marketing and information campaigns. In general, it was found that slightly more than half (55%) of the traveling population, as represented by the survey sample, knew that bus fares were free on forecast Code Red Days, while somewhat less than a third (29%) said that the free fare made them use or consider using the bus on forecast Code Red Days. Ultimately though, only 4% of the sample actually said they used bus on forecast Code Red Days and that free fare was a primary reason.

The importance of free fare in the attitude toward or decision to use bus on forecast Code Red Days was probed through several questions in the survey. Table 28 first examines the relationship between respondents saying they would consider using the bus on forecast Code Red Days in Question 7 with knowledge that the fares were free on these days in Question 8. Interestingly, not only did knowing that bus fares were free have little impact on commuters' decision to consider using bus (16% of those who know also considered using), but this knowledge did not produce a substantially different response than those who did not know that fares were free (9% considered using). Among non-commuters, the difference in considering bus was substantially greater between those who knew the fare was free (23%) and those who did not (4%). The reason for this difference is not clear, although non-commuters (persons engaged in discretionary travel) are generally more sensitive to cost than commuters.

Table 28 – Consider Using Bus on Forecast Code Red Days (Qu. 7), by Know Bus Fares are Free (Qu. 8)

	Consider Using Bus on Forecast Code Red Days				
	Consider	Not Consider	Blank	Total	Percent Consider
Commuters	37	168	7	212	17%
Know it's free	18	93	4	115	16%
Don't know	8	75	3	86	9%
Non-Commuters	12	75	1	88	14%
Know it's free	9	30		39	23%
Don't know	2	45	1	48	4%
All	49	243	8	300	16%
Know it's free	27	123	4	154	18%
Don't know	10	120	4	134	7%

Another way of probing the importance of free fare in bus use is by examining the reasons given in survey Question 7A for using or considering using the bus on forecast Code Red Days for those who said that they had considered using it in Question 7 (sample of 37 commuters and 12 non-commuters). Results are shown in Table 29. For commuters, only one-quarter to one-third of the respondents who considered using transit cited free fare as a reason, slightly less than the number who said they used the bus to reduce emissions. Among the 12 non-commuters who considered the bus, only 1 cited free fare as a reason for their decision. Again, reducing emissions was cited more frequently as a reason than free fare. There were not significant differences across jurisdictions, on the hypothesis that economic differences or level of fare might cause free fare to be a more important factor in some locations than others.

Table 29 –If Use Bus, Reasons for Using (Qu. 7A) by Jurisdiction

	Arlington County	Fairfax County	Loudoun County	Pr. William County	Alex-andria	Falls Church	Man-assas	All Juris-dictions
Commuter	7	22	3	4	1			37
Free Fare	2	7	1	1				11
Reduce emissions	3	6		2				11
Avoid congestion		2						2
Health reasons					1			1
Avoid heat	1	6		2				9
Pct. Citing $0 fare	*29%*	*32%*	*33%*	*25%*	*0%*			*30%*
Non-Commuter	3	4		3	1	1		12
Free Fare		1						1
Reduce emissions	1	2		1				4
Avoid congestion	2			1				3
Health reasons					1			1
Avoid heat								0
Pct. Citing $0 fare	*0%*	*25%*		*0%*	*0%*	*0%*		*8%*

Addressing this in a slightly different way, Question 9 in the survey specifically asked respondents whether getting a free ride on forecast Code Red Days made them consider taking the bus for trips that they might not ordinarily make by bus. Responses in relation to jurisdiction of residence and for commuters vs. non-commuters are shown in Table 30. Indeed, asked about free fare in this manner, 40% of commuters and 30% of non-commuters indicated that they would consider using bus if the fare were free. As in Table 23, commuters residing in Arlington County (60%) showed the greatest tendency of any market group to consider bus use under free fare conditions.

Table 30 – Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), by Jurisdiction

	Arlington County	Fairfax County	Loudoun County	Pr. William County	Alex-andria	Falls Church	Manassas	All Juris-dictions
Commuter								
Consider Using	12	41	9	15	6		2	85
Total Commuter Respondents	20	109	21	46	13		3	212
Pct. Consider	60%	38%	43%	33%	46%		67%	40%
Non-Commuter								
Consider Using	5	11	3	4	2	1	0	26
Total Non-Commuter Respondents	17	37	11	12	6	3	2	88
Pct. Consider	29%	30%	27%	33%	33%	33%	0%	30%
All								
Consider Using	17	52	12	19	8	1	2	111
Total Respondents	37	146	32	58	19	3	5	300
Pct. Consider	46%	36%	38%	33%	42%	33%	40%	37%

Table 31 addresses the same question in relation to primary mode (commuters only). Drive alone commuters are the least likely to consider using bus with free fare (36%), even though 54% were aware of free fare (Table 22). Meanwhile, as many auto passenger commuters who were aware of free fare in Table 22 indicated that free fare made them consider using bus (57%).

Table 31 – Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), by Primary Commute Mode

Primary Mode	Yes	No	Don't Know/ Unsure	Total	Percent Yes
Drive Alone	63	102	9	174	36%
Auto Passenger	4	3		7	57%
Metrorail	12	7	1	20	60%
VRE	2	2		4	50%
Bus	3	1		4	75%
Walk		2		2	0%
Bike	1			1	100%
Total	85	117	10	212	40%

Table 32 takes the tack of comparing whether the person ever used/considered bus (from question 7) with whether a free ride made them consider taking the bus on Code Red Days (Question 9). For commuters, there is a fairly high correspondence between having used bus on forecast Code Red Days and knowing that the fare was free (81%), although 31% who knew it was free did not consider using it. A similar relationship occurs among non-commuters, with a higher percentage having used/considered using bus knowing that the fare was free (42%) than those who knew fare was free but did not consider using (28%).

Table 32 -- Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), vs. Ever Used Bus on Forecast Code Red Days (Qu. 7)

	Free Ride Make You Consider Bus?				
Ever Used Bus on forecast Code Red Days?	Yes	No	Don't Know/ Unsure	Total	Percent Yes
Commuters	85	117	10	212	40%
Yes	30	6	1	37	81%
No/Don't Know	55	111	9	175	31%
Non-Commuters	26	58	4	88	6%
Yes	5	6	1	12	42%
No/Don't Know	21	52	3	76	28%
All	111	175	14	300	37%
Yes	35	12	2	49	71%
No/Don't Know	76	163	12	251	30%

Table 33 and Table 34 look at the correspondence between knowledge of free fare and willingness to use bus (Qu. 9) with transit availability (Qu. 12) and vehicle ownership (Qu. 13). The importance of transit availability is not as strong in explaining willingness of commuters to use bus with free fare as might be expected. Forty-six percent of those who say they have transit available say they would consider riding bus on forecast Code Red Days with free fare, whereas 36% of those who do not view transit as an available

option say they would consider using it anyway, perhaps meaning that if bus service were available, they would consider using it.

Table 33 -- Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), vs. Transit Available for Commute (Qu. 12)

	Yes	No	Don't Know/ Unsure	Total	Percent Consider
Commuter					
Transit Available	46	48	5	99	46%
Not Available	36	61	3	100	36%
Non Commuter	26	58	4	88	30%
Transit Available	NA	NA	NA	NA	NA
Not Available	NA	NA	NA	NA	NA
Total	108	167	12	287	38%

In relation to vehicle ownership, Table 34 once again indicates a decline in interest in using the bus for commuting, even with free fare, as more vehicles are owned by the household, whereas with non-commuters the relationship is once again counter-intuitive – households with more vehicles appear more likely to consider free fare bus than those fewer vehicles.

Table 34 -- Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), vs. Number Household Vehicles (Qu. 13)

	Consider Bus on Forecast Code Red Days?				
Number Vehicles	Yes	No	Don't Know/Unsure	Total	Percent Consider
Commuter					
0	1			1	100%
1	21	23	2	46	46%
2	43	46	5	94	46%
3	13	29	3	45	29%
4+	7	19		26	27%
Non-Commuter					
0	1	3		4	25%
1	8	26	3	37	22%
2	11	18	1	30	37%
3	4	5		9	44%
4+	2	6		8	25%
All					
0	2	3	0	5	40%
1	29	49	5	83	35%
2	54	64	6	124	44%
3	17	34	3	54	31%
4+	9	25	0	34	26%

Another cross-check to investigate consistency in reasoning was to compare responses to Question 9, whether they would ride the bus on forecast Code Red Days knowing fares are free, with Question 8, whether they knew fares were free on these days. Results as shown in Table 35 indicate that 40% of commuters who knew fares were free would consider riding vs. 36% who did not know they were free, and 33% of non-commuters who knew fares were free would consider riding compared to 27% who did not know. This result, if accurate, suggests that free fare does not make much difference to those deciding whether or not to use the bus on a forecast Code Red day.

Table 35 -- Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), vs. Know That Bus Fares are Free (Qu. 8)

	Free Ride Make You Consider Bus?				
Aware Fares Free on Forecast Code Red Days?	**Yes**	**No**	**Don't Know/ Unsure**	**Total**	**Percent Consider**
Commuters	77	115	9	201	23%
Yes	46	66	3	115	40%
No	31	49	6	86	36%
Non-Commuters	26	57	4	87	15%
Yes	13	25	1	39	33%
No	13	32	3	48	27%
All	103	172	13	288	36%
Yes	59	91	4	154	38%
No	44	81	9	134	33%

Finally, a question was asked to determine whether interest in the program would be any less if the bus fare were only lowered by half, instead of zero. Table 36 suggests that there would be a decline in interest and usage, by about 31% for commuters, 15% for non-commuters, and 27% overall. For those 111 people who indicated that they would consider riding the bus if the fare was free, 81, or 73%, reported that they would still be interested if the fare were only reduced by half. A higher proportion of non-commuters, 85%, retained interest in using the bus under half-fare than commuters, 69%.

Table 36 -- Free Ride Make You Consider Bus on Forecast Code Red Days (Qu. 9), vs. What if Fares Half Price (Qu.. 10)

	Consider Riding Bus if Free Fare (Qu 9)			If Yes, Consider Riding at Half Fare (Qu 10)		
	Yes	No/Don't Know	Total	Yes	No/Don't Know	Total
Commuters	85	127	212	59	26	85
	40%	60%	100%	69%	31%	100%
Non-Commuters	26	62	88	22	4	26
	30%	70%	100%	85%	15%	100%
All	111	189	300	81	30	111
	37%	63%	100%	73%	27%	100%

Overall Importance of Free Fare on Bus Use Decision

An overall summary of the influence – direct and indirect – of offering free bus fares on forecast Code Red Days is provided in Table 37. Looking first at those 49 travelers (16% overall) who claimed to have used bus on forecast Code Red Days, 12 of those cited free fare as one of the reasons for that choice. The other 37 users did not cite free fare as their reason, but 27 of those knew that bus fare was free on forecast Code Red Days, and all of those indicated that free fare was a factor that influenced their decision. So in effect, 80% of all persons who rode the bus on forecast Code Red Days (39 people) cited the existence of free fare, or the knowledge of free fare, as a factor in their choice.

Table 37 – Influence of Free Fare Program on Bus Use Decision

Total Sample	Used Bus on CRD	Free Fare the Reason	Know Fare is Free on Forecast CRD	Free Fare Make Consider Use	Overall Percent Influenced by Free Fare
300	49 yes	12 yes	12 yes	12 yes	4%
		37 other	27 yes	27 yes	9%
			10 no		
	251 no		127 yes	39 yes	13%
				88 no	
			124 no	37 yes	12%
				87 no	
	49 yes		166 yes	115 yes	38%
	16%		55%		

Among those 251 respondents who did not claim to ride the bus on forecast Code Red Days, 127 of those (about half) did know about the free fare opportunity, and 39 of those (31% of all who knew about free fare, and 16% of all those who didn't take the bus on a forecast Code Red Day) said that the free fare did make them consider using the bus on forecast Code Red Days. Interestingly, among the 124 persons who did not ride the bus and also did not know that bus fares were free on forecast Code Red Days, 37 indicated that the opportunity to ride fare free did make them consider taking the bus.

Hence, overall, while only 4% of all respondents said they took the bus on forecast Code Red Days, knowing the fare was free, 38% overall indicated that free fare on forecast Code Red Days was significant to them in using or considering to use the bus.

Changes in Travel

The goal of the Free Bus Fare program is to reduce the use of automobiles, and therefore automobile generated emission of ozone and other pollutants, on days that are forecast to have ozone levels that are, for one-hour, 125 or more parts per billion. Since automobile engine exhaust contains many components that contribute to the production of ozone, reductions in auto use can avoid exceedances or reduce the severity of exceedances. Reducing the number of days per year when there are exceedances is important in helping the metropolitan area maintain conformity with federal air quality standards. That, in turn, helps to avoid other, potentially more onerous actions, and ensure that federal funding for transportation programs is continued.

There are a variety of actions that travelers can take to reduce automobile use and emissions. Among these are staying home (i.e. not making trips to work or to other activities), telecommuting, carpooling in lieu of driving alone, or riding public transit in lieu of driving. The offer of free bus fares is just one element of a strategy to make the public aware of the need to reduce emissions and to encourage reduced auto use.

While this study is focused primarily on the free fare program and on the change in bus ridership resulting from the free fares, a number of data sources have been used to assess if there appear to be changes in travel patterns on days forecast to be Code Red Days.

VDOT Counts

The Virginia Department of Transportation (VDOT) maintains several permanent counting stations that continuously record the number of vehicles passing specific locations. The project team requested from VDOT counts from the locations shown in Table 38 below, for both forecast Code Red Days and similar days in preceding weeks, for the summer of 2002. The forecast and actual Code Red Days in 2002 are listed in Table 39.

Table 38 - VDOT Permanent Count Data Locations

Route	Direction	Location	Jurisdiction
66	East	0.5 Mi E RAMP FR RT 120	Arlington
1	Both	0.2 Mi N RTE 235-S INTERSECTION	Fairfax
7	West	0.2 Mi W RTE 495	Fairfax
50	West	0.15 Mi W WAYNE RD	Fairfax
267	East	1.7 Mi E RTE 674	Fairfax
395	South	0.2 Mi S RAMP Fr RTE 236 (New LOC)	Fairfax
495	North	0.21 Mi N OLD DOMINION DR. (RTE. 738)	Fairfax
7100	South	0.5 Mi S RTE 50	Fairfax
7	West	0.1 Mi W RTE 7 BUS	Loudoun

Table 39 - Forecast and Actual Code Red Days 2002

Forecast Code Red Days Summer 2002					
Day of Week	Date	Forecast Code Red	Actual Code Red	Actual Code Orange	Free Fare
Wed	5-Jun			X	
Thu	6-Jun			X	
Mon	10-Jun		X		
Tue	11-Jun	X	X		X
Sat	22-Jun			X	
Mon	24-Jun	X		X	X
Tue	25-Jun	X	X		X
Mon	1-Jul			X	
Tue	2-Jul		X		
Wed	3-Jul	X		X	X
Mon	8-Jul			X	
Tue	9-Jul			X	
Wed	12-Jul			X	
Wed	17-Jul	X		X	X
Thu	18-Jul			X	
Fri	19-Jul			X	
Thu	1-Aug			X	
Fri	2-Aug	X	X		X
Sat	3-Aug	X	X		X
Sun	4-Aug			X	
Mon	5-Aug	X		X	X
Sun	11-Aug	X		X	X
Mon	12-Aug	X	X		X
Tue	13-Aug	X	X		X
Wed	14-Aug	X		X	X
Mon	19-Aug			X	
Tue	20-Aug			X	
Fri	13-Sep		X		

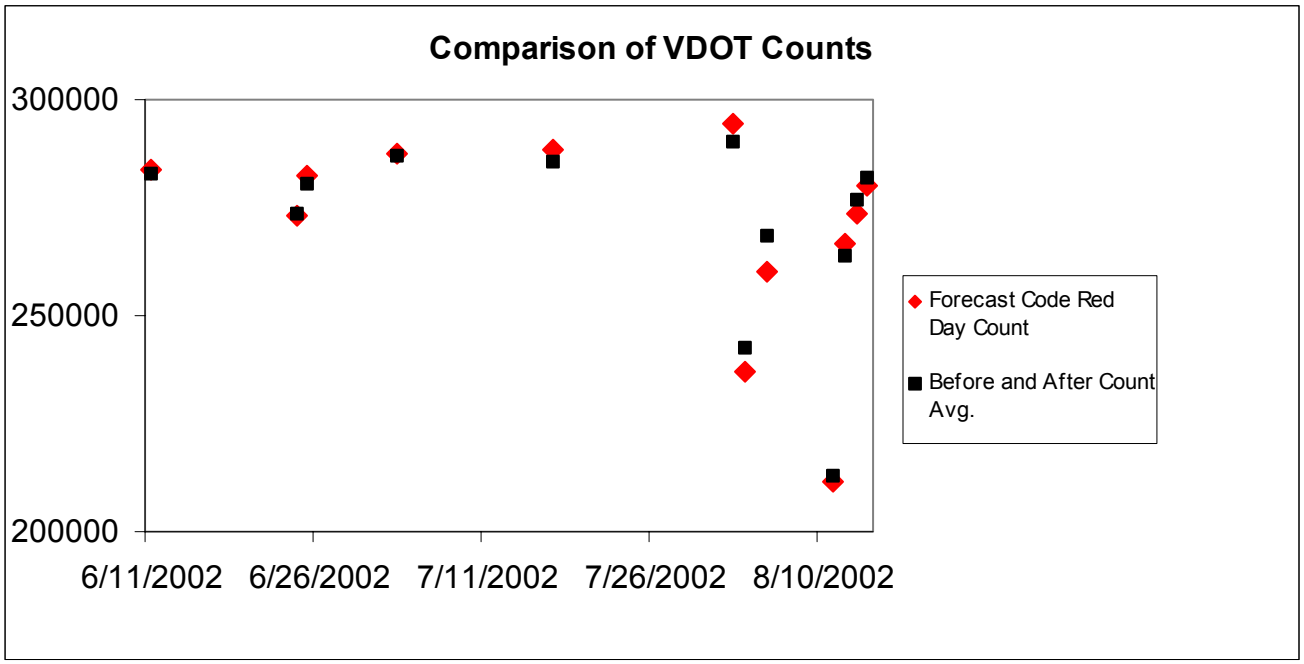
Note: Free Fare Days are highlighted

The data were analyzed in two ways. The first analysis, Figure 1, shows the total traffic counted at the selected stations for the forecast Code Red Day compared to the average of the counts from the same weekday in the previous and following week. Because data from some stations were not available for all days, data were used only from stations

that had counts on all three days (forecast Code Red Day, one week prior and one week past) for all twelve free fare forecast Code Red Days in 2002.

The analysis showed that the traffic counts on the free fare days were very similar to the average of the counts from one week prior and one week after.

Figure 1 : Traffic Counts on Code Red Days vs. "Typical" Days

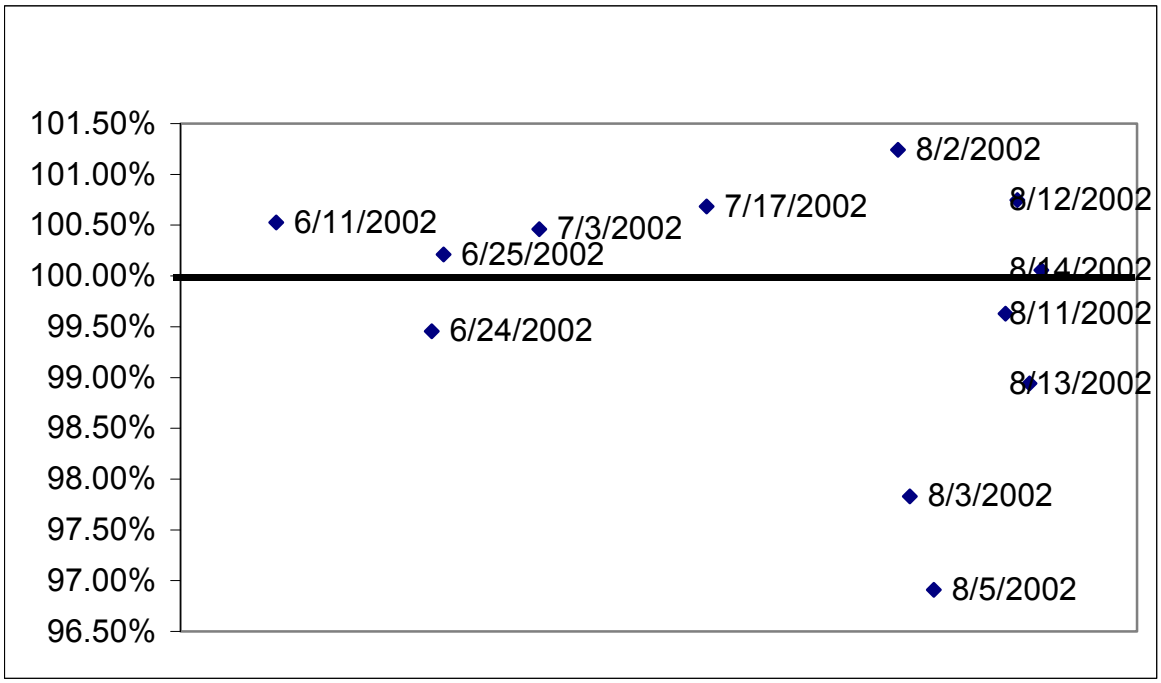


Note: Only counts from stations that could provide all necessary data were used.

The second analysis shows the free fare day count as a **percentage** of the average from the same weekday in the week prior and the week following the predicted Code Red Day. Each day was analyzed separately using data from stations that could provide counts for each of the three associated days (forecast Code Red Day, one week prior and one week after). Because some stations could not provide all necessary data for some forecast Code Red Days, totals for different forecast Code Red Days are not compared to one another. For example: all three counts (forecast Code Red Day, one week prior and one week after) were not available from the station on the Fairfax County Parkway for the June 11, 2002 free fare day, therefore they were not included in the total for that day. But the counts for that station were available for all three days associated with the free fare day on June 24, 2002 and, therefore, were included in the total.

Figure 2 shows the free fare day traffic count sum for the selected stations as a percent of the average from the same weekday in the week prior and the week following the forecast Code Red Day. These analyses show no obvious correlation between the free fare days in 2002 and the total travel on the roadways for those days. The issuing of Code Red warnings seems to have little effect on overall regional travel.

Figure 2: Forecast Code Red Day Count As Percent of the Average of One Week Before and After



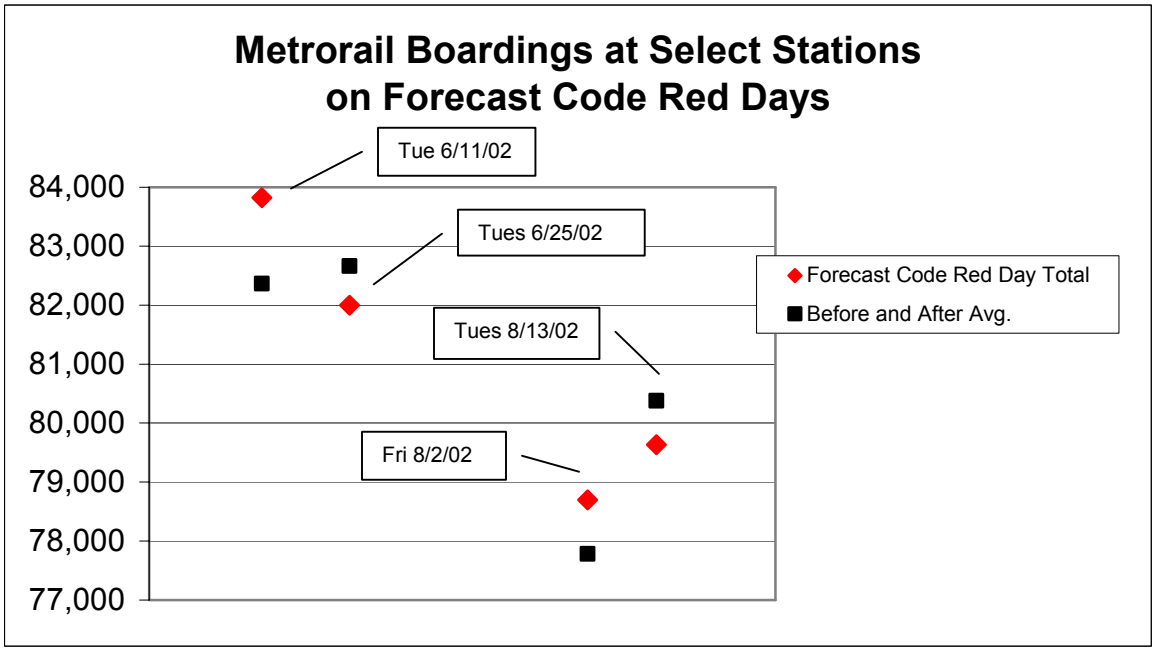
Metrorail Ridership

If there is a significant change in bus use on forecast Code Red Days, there should also be a change in the number of persons boarding Metrorail at key transfer stations. Counts of bus ridership, particularly on free fare days, depend upon the diligence of the bus drivers in clicking the counters to record passenger boardings. Metrorail boardings require use of a Farecard, SmartPass or similar medium. The boardings are counted electronically and should be more accurate.

The Washington Metropolitan Area Transit Authority (WMATA) provided data on boardings at selected stations in Northern Virginia on forecast Code Red Days in 2002. The selected stations were those that are the connecting points for multiple bus routes - Pentagon, Ballston, Vienna, Rosslyn, West Falls Church and Franconia-Springfield. The total boardings for each of the forecast Code Red Days were compared to the average of the total boardings for the day one week prior and one week after (Before and After Average) the forecast Code Red Day. Complete data were available only for four of the twelve forecast Code Red Days in 2002. On two of those four days the boardings on the forecast Code Red Days were higher than the Before and After Average. On two of the four days the boardings on forecast Code Red Days were lower than the Before and After Average. In both cases in which the forecast Code Red Day boardings were greater than the Before and After Average, Metrorail boardings at the selected stations were 101% of the Before and After Average. In both cases in which the forecast Code Red Day boardings were lower than the Before and After Average, the forecast Code Red Day boardings were 99% of the Before and After Average. Figure 3 illustrates the

comparison of the total boardings on four forecast Code Red Days to the average of the same weekdays in the previous and following weeks.

Figure 3: Analysis of Metrorail Boardings on Code Red Days



These limited data reveal no obvious relationship between boardings at Northern Virginia Metro Stations on forecast Code Red Days and boardings on typical days.

Bus Ridership and Revenue Analysis

Bus operators participating in the forecast Code Red Day free fare program are compensated for the loss of revenue on the free fare day based on an estimate of the farebox revenue they would have expected were the free fare program not in effect. This estimate is the average of the farebox revenue collected on the same day of the week (e.g., Wednesday) in the three previous weeks. The revenue reimbursement paid to the operators is in no way related to the ridership carried on either the forecast Code Red Day on the previous "typical days." The farebox revenue data are thought to be quite accurate, since transit agencies maintain strict control of revenues and have stringent procedures to count money.

In addition to furnishing the farebox revenue data to NVTC to obtain reimbursement for lost fare revenue, the operating agencies also furnish to NVTC a report of the ridership carried on the forecast Code Red Day and an estimate of the ridership they would have normally carried on that day. There is far less attention given to recording ridership than to counting money. Ridership counts can be developed from several sources. Most fareboxes record a transaction when cash is deposited. When passengers board with a transfer or pass, drivers are required to note the transaction by clicking a counter mounted near the farebox. On a typical day, when fares are required, drivers are usually diligent in recording passenger boardings, but even on those days some activity may go

unrecorded. On free fare days the operators are instructed to count passenger boardings in the same manner. However, since boarding passengers need not drop coins or show a pass, events requiring interaction with the drivers, the missed counts may be significantly greater, especially when many passengers are boarding at one time. There is a suspicion that the counts of ridership on free fare days are less accurate than the revenue data. As discussed in more detail below, the data appear to support this conjecture.

These ridership and associated "lost revenue" data (what they would have earned on a normal day) provide a means to begin to track and evaluate the performance of the forecast Code Red Day free fare program. By comparing the "average day" ridership with the "actual" ridership counted on the forecast Code Red Days, an estimate can be made of the program's effectiveness in attracting bus riders and reducing VMT and emissions. Appendix A provides a complete record of the ridership counts and estimated gains for each operator on each of the twenty-nine forecast Code Red Days that have been called in Northern Virginia since the program's inception in 1999 through the 2003 season.

Several things are evident from an inspection of the ridership data. First, the number of forecast Code Red Days greatly varies from year to year. There were seven forecast Code Red Days called in 1999 but only two in 2000, then five in 2001, a high of twelve in 2002, and again only two in 2003. Second, these days fall in each of the three primary ozone months of June (May/June), July and August, and on each day of the week including weekends. Some of the systems, Loudoun and Prince William (PRTC) Counties, have no weekend service, so there are no data on these days. Arlington and Alexandria did not provide weekend service during the early years of the program. Third, many of the systems would appear to have lost riders on Code Red Days, in spite of free fares, since ridership reported on free fare days was actually less than on the comparable average days. Fourth, the size of the 7 systems varies greatly, with the Arlington and Loudoun systems carrying about 1,000 to 2,000 per day, while large systems like Fairfax Connector and Metrobus carry in the range of 30,000 and 90,000 riders per day, respectively.

Ridership Data Variation and Quality

Part of the difficulty in assessing the effect of the Code Red Day free fares on bus ridership is that the change may be within the range of normal day-to-day variation. To better understand the range of variation, the bus ridership reported in summer 2002 by Metrobus and Fairfax Connector for both forecast Code Red Days and other days was analyzed.

Inspection of the ridership data also reveals some unanticipated variations in "normal day" ridership, not only between days of the week but also between consecutive calendar days in a multi-day forecast Code Red episode. This variation raises concern as to the accuracy of the counts made by the operators, both on regular days and forecast Code Red Days, and is suspected to be a major factor in the number of occasions when ridership losses rather than gains are shown for forecast Code Red Days on which fares were free. These concerns are especially raised for the two largest systems, Metrobus and Fairfax Connector, which show considerable variation in daily

ridership and also report substantial ridership losses on forecast Code Red Days in the first three years of the program.

Figure 4 illustrates Metrobus ridership for selected days between mid-May and late August of 2002. There is an apparent pattern of a ridership decline in early June with a steady increase through the summer. Reported daily boardings range from a low of 60,000 to a high of almost 110,000. The highest reported value is almost twice the lowest.

Figure 4: Metrobus Weekday Ridership (Northern Virginia)

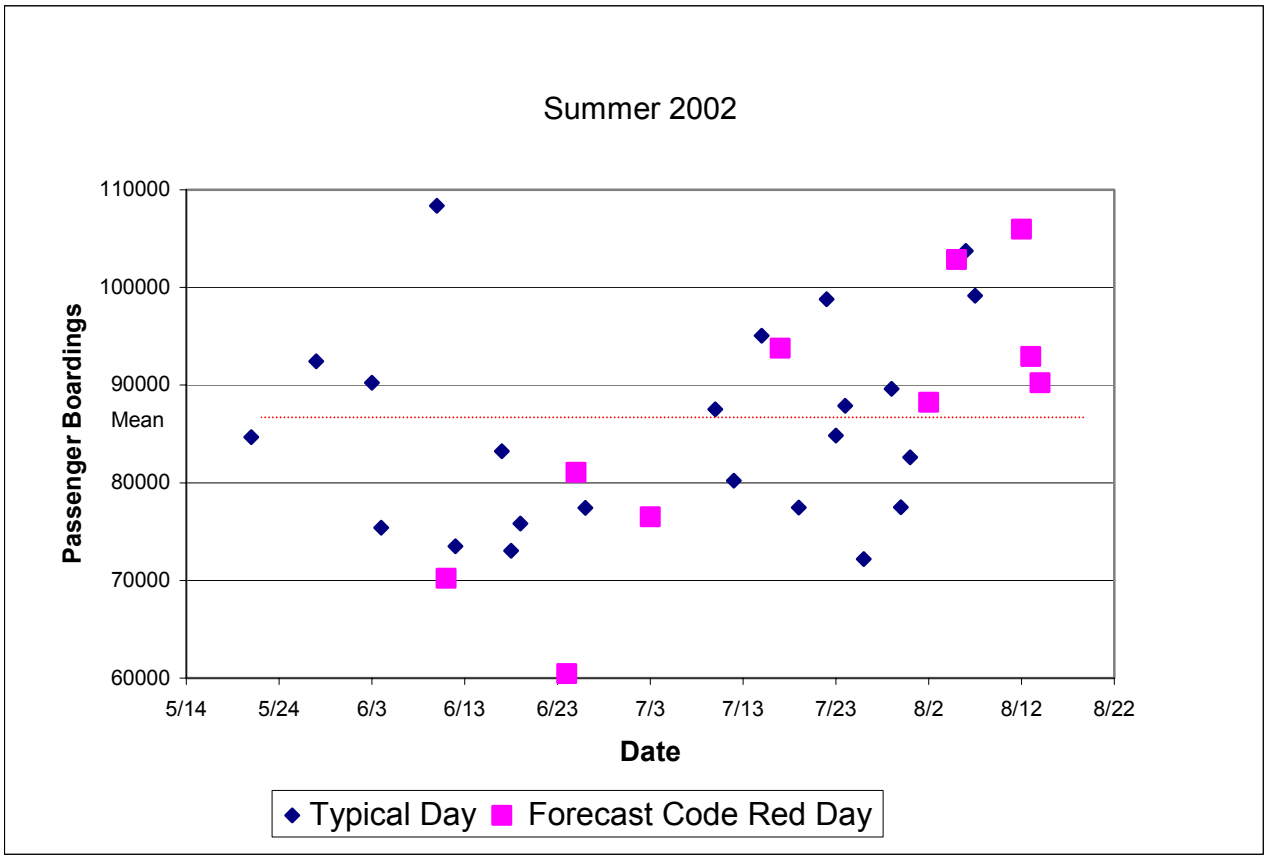
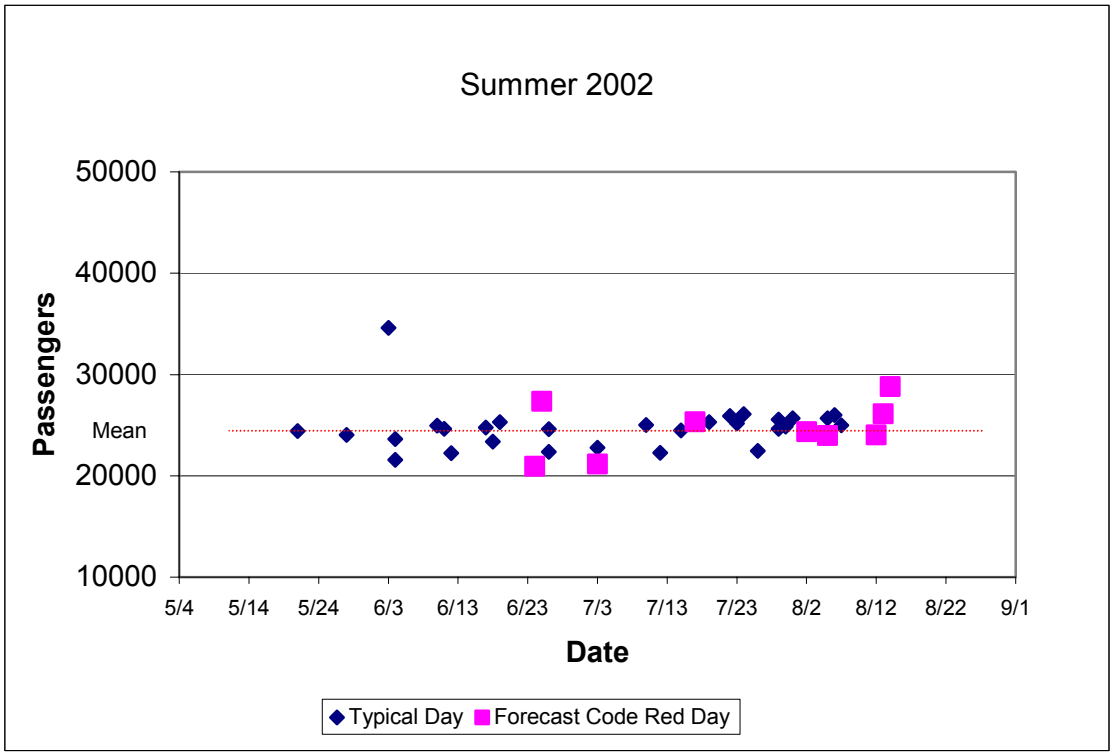


Figure 5 presents similar data for the Fairfax Connector. Here, too, the data suggest a possible trend for an increase through the summer. Here, too, there is significant variation with the high reported boardings of 33,000 more than half again as large as the low value of just over 20,000.

For both systems ridership gains of 5% to 10% on forecast Code Red Days could easily be obscured by daily variation.

Figure 5: Fairfax Connector Ridership



The variation in reported daily boardings also has an effect on the assessment of the effectiveness of the free fares. Note in **Figure 5** the very high ridership reported on June 3. This possibly anomalous value was included in the computation of the "average" day against which ridership on the forecast Code Red Day on June 24 was measured. The result was an apparent substantial loss in ridership when, in fact, the reported ridership was lower than average but quite consistent with the general pattern.

A broader issue is the validity of the boarding counts. For these two largest systems the standard deviation in reported ridership is 10% to 15% of the mean. For the other systems the ratio is 3% to 4%. Further investigation of the typical ridership patterns and of the mechanisms used to gather and report ridership are needed to fully understand the forecast Code Red Day free fare effects.

Changes in Bus Ridership on Forecast Code Red Days

Table 40 summarizes the ridership changes reported by the transit agencies on forecast Code Red Days when bus fares are free. These changes are determined by comparing the ridership counts on the forecast Code Red Days with free fare against "normal" ridership, as represented by the average ridership on the same day of the week recorded over the preceding three weeks. Ridership numbers shown in parentheses reflect ridership totals on forecast Code Red Days free fare days that are lower than the average represented by the prior three control days. As discussed in the previous section, there are outstanding questions of reliability posed by the reported ridership data, particularly in the early (first three) years of the program. The general trend

appears to be an improvement in ridership over time as more familiarity is gained with the program. However, whether this trend is due to increased public familiarity with the program or improved counting procedures by operators remains an unresolved issue at this interim evaluation stage.

Table 40 – Reported Bus Ridership Changes on Forecast Code Red Days

	1999	2000	2001	2002	2003	Total
Arlington	263	0	230	510	341	1,344
DASH	5,730	(83)	6,100	18,814	4,524	35,085
PRTC	(396)	0	2,322	6,007	1,540	9,473
Loudoun	217	0	157	344	194	912
Fairfax	(10,228)	(361)	(7,110)	(2,682)	1,167	(19,214)
CUE Bus	(1,388)	298	835	467	368	580
WMATA	(58,609)	(6,365)	(126,167	8,191	32,537	(150,413
ALL	(64,411)	(6,511)	(123,633	31,651	40,671	(122,234
Number of Forecast Code Days	8	2	5	12	2	29
Per Day	(8,051)	(3,256)	(24,727)	2,638	20,336	(4,215)

Code Red Ridership Performance by Operators Over Time

The following series of tables explore general trends in the operator-provided ridership data. Various hypotheses are tested to ascertain whether the timing of Code Red events – e.g., by day of week, month, or consecutive days of a Code Red episode – have any bearing on the ridership changes observed. Table 41 illustrates the ridership changes on Code Red Days calculated from the ridership data provided by the operators. The changes are shown as a percentage increase or decrease in the ridership against the average day, with the number of forecast Code Red Days included in the average for that year shown in parentheses below.

Table 41 – Ridership Changes, by Operator, on Forecast Code Red Days, by Year

Percent Change in Ridership on Forecast Code Red Days
(number of forecast Code Red Days reported in period)

Year	Arlington	DASH	PRTC	Loudoun	FFX Conn	CUE Bus	WMATA	All
1999	15% (4)	12% (8)	-3% (4)	8% (4)	-12% (7)	-9% (7)	-24% (5)	-16% (7)
2000	NA (0)	-1% (2)	NA (0)	NA (0)	-5% (2)	21% (2)	-21% (1)	-15% (2)
2001	12% (5)	12% (5)	9% (5)	4% (5)	-6% (5)	5% (5)	-30% (5)	-20% (5)
2002	4% (12)	17% (12)	9% (10)	4% (10)	-1% (12)	1% (12)	1% (12)	2% (12)
2003	8% (2)	21% (2)	10% (2)	7% (2)	2% (2)	6% (2)	22% (2)	16% (2)
Avg. 1999-2003	7% (23)	15% (29)	8% (20)	5% (21)	-4% (29)	1% (29)	-9% (25)	-4.5% (29)
Avg. 2002-2003	5% (14)	18% (14)	9% (12)	4% (12)	-0.50% (14)	2% (14)	4% (14)	4.4% (14)

Overall, for the 5 years since program inception, the reported data show that ridership on forecast Code Red Days exhibits a net 4.5% rider loss, with the total being dominated by the results from Metrobus and the Fairfax Connector. This apparent finding requires careful consideration. There is no reason why the lack of the need to pay fare should lead to a loss of riders. No rational traveler would forgo a free trip when they would normally have to pay. There are several possible explanations:

- The general conditions of days when pollution exceedances are expected – typically very hot, humid, difficult for persons with respiratory problems – may lead to travelers who would usually ride transit to either choose another mode or stay home. There is some evidence from the phone survey that staying home may be seen as an appropriate response to an Ozone Alert. If this occurs, transit ridership would decline. The effect of the free fare program on travel and emissions would be diminished to the extent of this loss.

- Since fares are free, bus drivers are not as diligent in counting boarding passengers. Since no farebox revenue is collected there is no way to check the validity of the reported driver counts.

- Regular riders and prospective new riders may shun bus use on forecast Code Red Days if they think that free fares would lead to overcrowded buses.

The degree to which regular riders abandon the bus on Ozone Alert Days only to be replaced by new riders attracted by the free fare cannot be assessed without the on-board survey information.

Regardless of the cause of the apparent lower ridership on free fare days in the early years of the program, over time results have improved for almost all operators and for the system as a whole. If one looks only at performance for the last two years, the

program is showing a net gain of 4.4% of riders on forecast Code Red Days when fares are free. While most of the individual systems are showing positive numbers by 2002-2003, it should be stressed that the big reason for the positive result for the system as a whole is the steady improvement of reported Metrobus ridership on forecast Coder Red Days since 2001. It is not clear, however, whether these improvements in Metrobus performance are the result of better utilization/management of the program or whether passenger counting procedures have been improved.

Differences in Ridership by Month

One hypothesis tested to help explain the variations seen in the performance of the Code Red Day free fare bus program was to look at differences in ridership gain in relation to the month that the Code Red episode occurred. Table 42 displays average ridership gain by system for each of the three typical ozone months – June, July and August – with each month showing a compilation of all forecast Code Red Days that occurred in that month over all years of the program.

Table 42 – Reported Forecast Code Red Day Ridership Change by Month

Percent Change in Ridership on Forecast Code Red Days, 1999-2003
(number of forecast Code Red Days reported in period)

Month	Arlington	DASH	PRTC	Loudoun	FFX Conn	CUE Bus	WMATA	All
May/June	14%	15%	7%	6%	-5%	3%	-16%	-9%
	(10)	(13)	(10)	(10)	(12)	(12)	(11)	(13)
July	2%	19%	6%	2%	-9%	-5%	-9%	-4%
	(4)	(7)	(4)	(4)	(7)	(7)	(4)	(7)
August	0%	13%	9%	4%	0%	2%	-2%	0%
	(9)	(9)	(7)	(7)	(9)	(9)	(9)	(9)
Years 2002 & 2003 Only								
May/June	15%	19%	10%	6%	-1%	6%	-3%	0%
	(5)	(5)	(4)	(5)	(5)	(5)	(5)	(5)
July	-6%	27%	8%	-2%	-2%	-5%	1	3%
	(2)	(2)	(2)	(2)	(2)	(2)	(1)	(2)
August	-2%	14%	8%	5%	0%	1%	8%	7%
	(7)	(7)	(5)	(5)	(7)	(7)	(7)	(7)

The hypothesis was that episodes in June might garner more riders because household travel and highway traffic would still be at normal levels, i.e., summer vacation absences would not yet be fully in effect, whereas in August the largest number of people would be on vacation and fewer people would have their regular local travel influenced by a forecast Code Red Day. However, the opposite appears to be true: when the entire 5 year program data are used, shown in the top half of Table 42, May/June shows a loss of 9% in riders, July a loss of 4%, and August breaking even (i.e., the best performing month). Looking at only the more reliable 2002-2003 data, shown in the bottom of Table 42, the same relationship holds, but with non-negative ridership changes for each: August ridership shows an increase of 7%, July an increase of 3%, and June ridership at break even (0%).

Differences in Ridership by Day of Week

A similar hypothesis was tested on the assumption that ridership gains would be more substantial on forecast Code Red Days occurring during the week than on weekends, and among weekdays, that ridership gains would be greatest during the middle part of the week (Tuesday, Wednesday, Thursday) rather than the outer days, Monday and Friday, which are occasionally tied in with the weekend and have lower travel levels. Table 43 summarizes these relationships for both the full 5-year period and the most recent 2 years.

Looking at the full 1999-2003 data record, weekdays averaged a reported loss of 5% while weekends lost an average of 6%. If only the 2002-2003 data are consulted, when ridership gains replace the 1999-2003 "losses", weekend ridership gains were slightly higher than weekday, 6% vs. 4%, but comparable to mid-week, both at 6%.

Effect of Consecutive Forecast Code Red Days

Still another hypothesis investigated to try to better understand patterns in the ridership data was to look at trends in ridership over consecutive days on those occasions when a forecast Code Red Day episode continued for several days. Each of the days in the sample of 29 forecast Code Red Days was separated out with regard to whether it was the first day of an episode, the second day in an episode, or the third or later day in an episode. Comparative results are shown in Table 44.

The hypothesis in this case was that if forecast Code Red Days fell on consecutive days, ridership might increase on the second day because people had a chance to think about their choices, but might fall on the third day as they might make other arrangements. Looking at the full 5-year data record, it appears that the hypothesis is partially true – first day ridership is lower than the second day, but third day is much better than day 1 or 2. However, looking at just 2002-2003 data, ridership increases are greatest on day 2 at 7%, an increase over 2% on day 1, but day 3 still remains higher than day 1 at 5%. In other words, it appears that interest in taking advantage of the free bus fare program grows with consecutive days of a forecast Code Red event.

Table 43 – Ridership Change on Forecast Code Red Days by Day of Week

Percent Change in Ridership on Forecast Code Red Days, 1999-2003
(number of forecast Code Red Days reported in period)

Day of Week	Arlington	DASH	PRTC	Loudoun	FFX Conn	CUE Bus	WMATA	All
Monday	5% (5)	14% (5)	3% (5)	6% (5)	-11% (5)	-10% (5)	-12% (5)	-9% (5)
Tuesday	18% (4)	14% (4)	8% (4)	6% (4)	4% (4)	6% (4)	-8% (4)	-3% (4)
Wednesday	3% (6)	18% (6)	8% (6)	3% (6)	0% (6)	3% (6)	-9% (5)	-3% (6)
Thursday	8% (3)	15% (3)	11% (3)	6% (3)	-8% (3)	3% (3)	-17% (3)	-11% (3)
Friday	5% (3)	14% (3)	8% (3)	5% (3)	2% (3)	1% (3)	-1% (2)	2% (3)
Weekday	**7% (21)**	**15% (21)**	**7% (21)**	**5% (21)**	**-3% (21)**	**0% (20)**	**-10% (19)**	**-5% (21)**
Mid Week	**8% (13)**	**16% (13)**	**8% (13)**	**4% (13)**	**-1% (13)**	**4% (13)**	**-11% (12)**	**-5% (13)**
Saturday	-33% (1)	16% (4)	NA (0)	NA (0)	-18% (4)	7% (4)	-10% (3)	-7% (4)
Sunday	24% (1)	10% (4)	NA (0)	NA (0)	-14% (3)	29% (3)	-5% (2)	-3% (4)
Weekend	**-13% (2)**	**13% (8)**	**NA (0)**	**NA (0)**	**-17% (7)**	**11% (7)**	**-7% (5)**	**-6% (8)**
Years 2002 & 2003 Only								
Monday	5% (3)	13% (3)	5% (3)	4% (3)	-13% (3)	-1% (3)	-5% (3)	-4% (3)
Tuesday	16% (3)	15% (3)	10% (3)	5% (3)	8% (3)	7% (3)	-4% (3)	1% (3)
Wednesday	0% (4)	23% (4)	10% (4)	3% (4)	6% (4)	1% (4)	9% (3)	11% (4)
Thursday	8% (1)	21% (1)	12 (1)	0% (1)	-7% (1)	0% (1)	16% (1)	10% (1)
Friday	1% (1)	12% (1)	15% (1)	4% (1)	4% (1)	-5% (1)	15% (1)	12% (1)
Weekday	**6% (12)**	**18% (12)**	**9% (11)**	**4% (12)**	**0% (12)**	**1% (12)**	**2% (11)**	**4% (12)**
Mid Week	**7% (8)**	**20% (8)**	**10% (7)**	**4% (8)**	**5% (8)**	**3% (8)**	**4% (7)**	**6% (8)**
Saturday	-33% (1)	27% (1)	NA (0)	NA (0)	-16% (1)	12% (1)	1% (2)	1% (1)
Sunday	24% (1)	28% (1)	NA (0)	NA (0)	-8% (1)	36% (1)	17% (1)	14% (1)
Weekend	**-13% (2)**	**27% (2)**	**NA (0)**	**NA (0)**	**-13% (2)**	**20% (2)**	**8% (3)**	**6% (2)**

Table 44 – Comparison of Ridership Changes by Consecutive Days of a Forecast Code Red Episode

Percent Gain in Ridership on Forecast Code Red Days, 1999-2003
(number of forecast Code Red Days reported in period)

Day of Episode	Arlington	DASH	PRTC	Loudoun	FFX Conn	CUE Bus	WMATA	All
Day 1	10% (8)	13% (10)	5% (7)	5% (7)	-8% (10)	1% (10)	-15% (9)	-0% (10)
Day 2	8% (7)	14% (10)	8% (5)	5% (6)	-5% (10)	3% (10)	-10% (8)	-5% (10)
Day 3+	3% (4)	16% (4)	10% (4)	8% (4)	5% (4)	-1% (4)	-6% (4)	-1% (4)
Years 2002 & 2003 Only								
Day 1	10% (4)	18% (4)	11% (3)	6% (3)	-4% (4)	5% (4)	1% (4)	2% (4)
Day 2	7% (4)	17% (4)	10% (3)	5% (3)	-1% (4)	2% (4)	9% (4)	7% (4)
Day 3+	-2% (2)	14% (2)	11% (2)	9% (2)	8% (2)	5% (2)	3% (2)	5% (2)

Bus Rider Characteristics

Assessment of the change is automobile use resulting from the Free Fare Program requires information about both the change in bus ridership on Free Fare Days and the characteristics of the bus riders on these days. To obtain this information a survey of riders on selected bus trips of each of the participating bus systems was to be conducted. A survey form was developed and reviewed with the project Technical Committee. A sample of bus trips to be included in the survey was developed. Survey forms were printed. A survey crew was recruited, trained and given instructions for deployment when a Code Red Ozone Alert Day would be forecast.

During the summer of 2003 there were two Code Red Ozone Alter Days forecast. These were June 25th and 26th. At this stage of the project the on-board survey forms were not yet fully approved and had not been printed. A survey on those days was not feasible. To the benefit of the Washington Metropolitan Area but to the detriment of the survey effort, there were no further Code Red Ozone Alert Days forecast. As there were no Free Fare Days, the anticipated surveys were not conducted. Data on bus rider characteristics were not collected and are not available for analysis or inclusion in this report.

Should NVTC determine that the program evaluation requires the collection of these data, the surveys will be conducted on forecast Code Red Days, if any are forecast, in the summer of 2004.

On-board Survey

There are several questions related to the effects of the free fare program for which data can be obtained only from a survey of persons riding the bus on a free fare day. These relate to whether to persons on the bus are regular riders or new riders, the distance of the trip being made and, for riders attracted by the free fare, the mode that would otherwise have been used.

An on-board survey to capture the needed data was planned for summer of 2003. However, the survey from was not approved for use until late June. By that time two forecast Code Red Days had occurred but it was fully expected, based on the 2002 experience, that there would be additional Code Red Days forecast later in the summer. It was anticipated that the surveys would be conducted on those days. A survey crew was recruited and trained. Work assignments were made. Staff was provided with instructions and materials so that they could respond for their work assignments when a free fare day was declared. Although all preparations were made to respond, no further Code Red Days were forecast in 2003.

Lacking the on-board survey data about bus rider characteristics the finding in this Interim Report are based on the data that were available.

Questionnaire

The questionnaire developed for the on-board rider survey was designed to address several primary questions:

- What proportion of the riders using a bus on a free fare day are riders who would not use the bus on a typical day? From this it will also be possible to estimate the proportion of regular bus riders who chose to make alternative arrangements on the Ozone Alert Day.

- To what extent did the free fare influence their decision to use the bus?

- What is the origin-destination pattern of the "new" riders? This is needed to estimate the vehicle-miles of travel and related emissions that would have been generated if the traveler had driven an auto rather than riding the bus.

- What mode would have been used if the trip were not made by bus?

The forms required to conduct the on-board survey were printed. Each form bears a unique serial number that will permit associating returned forms with the specific bus trip on which it was distributed. The single page form is printed on card stock. The survey is printed in Spanish on one side and in English on the other side. The project committee discussed the need for forms in other languages. The decision was that it was not likely that riders from any single language group, other than Spanish or English, would be found in sufficient number to warrant special forms. A copy of the English version of the questionnaire is presented in Appendix B.

Sample Selection

The free fare program is offered throughout the entire day on seven bus systems in Northern Virginia. In order to obtain data representative of riders on all participating systems a sampling plan was devised. The plan identified specific bus trips on routes of various types – express, local, circulator – and a varying times of day – morning peak, midday, afternoon peak- on each of the seven systems. These trips were also chosen to permit efficient utilization of survey staff. A similar bus trip sampling plan will be devised, based on then current operating schedules, should the project be extended though 2004.

Data and Tabulations

Data from the on-board survey will be key-entered. Tabulations and cross-tabulations will be prepared, similar to those developed from the telephone survey, exploring bus rider characteristics and trip patterns. Information necessary for the desired analyses will be developed.

Analysis

Analysis will be conducted to determine how bus ridership on Code Red free fare days differs from ridership on typical days and how this relates to change in automobile generated emissions.

Key Findings

The key findings from the on-board survey, if conducted in the summer of 2004, will be summarized in a Technical Memorandum and included in the project evaluation and Final Report.

Emission Impacts

Emissions Analysis

The primary reason for conducting the forecast Code Red Day free fare program is to reduce emissions on extreme pollution days when the one-hour NAAQS standard for ozone is likely to be exceeded. While offering free bus fares has the ancillary benefits of attracting new riders to transit and reducing vehicle travel and traffic congestion on these days, the ultimate goal for which the program is funded is to reduce emissions on these occasions. Hence, the major purpose of this evaluation was to gather the appropriate data to ascertain how effectively the fare free program reduces emissions.

Since the on-board survey is such a central element in the analytic approach, the inability to implement the survey over the Summer of 2003 seriously limited the ability to accomplish the key evaluation objective. In place of the on-board survey data, with its critical information on origin-destination, frequency, trip purpose, time of day, and usual mode, an interim estimate of the impact of the free fare program has been derived from the operator-provided ridership and revenue data. A series of assumptions have been made for translating the reported bus ridership changes into vehicle trip and VMT reductions, and thence to emissions savings. The reader is cautioned to treat these interim results with due caution, given the described concerns with the accuracy of reported ridership and revenue data, as well as the assumptions that have had to be made with respect to prior mode and other supporting characteristics.

The assumptions and steps used to develop travel and emissions impact estimates from the ridership/revenue are described below.

- Trip Purpose: It was assumed that all of the additional bus riders carried on free fare days were commuters, traveling on weekdays during the morning and evening peak period. Clearly this is not the case, particularly on weekend forecast Code Red Days, but the assumption is necessary because of lack of data on non-work or off-peak and weekend bus use. If non-work bus trips are of shorter length, or are comprised more heavily of prior auto passenger or non-motorized modes, then this assumption will cause VMT and emissions estimates to be overstated.

- Prior Mode and Vehicle Trips reduced: It would be incorrect to assume that each new bus rider gained on a free fare day represents a vehicle trip removed from the roads. Rather, riders diverted to bus would generally be expected to mirror the mode choice patterns among the traveling public at large. And as noted in the preceding assumption, mode choice data are not available for non-commuters. When MWCOG staff performs an analyses such as this involving changes to transit cost or service, a uniform assumption is applied of each new transit trip supplanting 0.75 private vehicle trips. For this analysis it is possible to sharpen this assumption using 2000 Census journey-to-work data, that report commuter mode shares for each of the study jurisdictions. As the various operators serve fairly specific jurisdictions, it is possible to estimate vehicle trip diversion rates for each jurisdiction and operator. Table 45 illustrates the steps in calculation of the bus-to-vehicle trip diversion rates. Commuter mode shares for each jurisdiction are shown as taken from the 2000 Census data. To calculate the number of vehicle trips eliminated for each diverted bus rider, it is assumed that that the new bus riders will come proportionately from existing proportions of drive alone (DA), carpool (CP), taxi & motorcycle (MC), and bike and walk. Since this is a program specific to bus transit, it is also assumed that free fares on buses will not divert existing transit riders from Metrorail or VRE, hence transit riders are taken out of the base of potential riders considered. Obviously, bike and walk trips diverted to bus eliminate no vehicle trips, and carpool trips are assumed to reduce ½ vehicle trip per diverted bus rider.

Table 45 -- Calculation of Vehicle Trip Rates for Diverted Bus Riders

Jurisdiction	Number of Commuters	Commuter Mode Shares						Vehicle Trips per Diverted Bus Rider
		DA	CP	Taxi/ MC	Bike/Wk/ Other	Transit	All Modes less Transit	
Arlington	112,158	56.8%	11.9%	0.5%	7.0%	23.8%	76.2%	0.830
Alexandria	74,498	65.1%	13.6%	0.6%	4.2%	16.5%	83.5%	0.868
Fairfax Co.	505,441	76.6%	13.6%	0.2%	2.1%	7.5%	92.5%	0.904
Falls Church	5,558	66.4%	12.1%	0.8%	4.6%	16.1%	83.9%	0.873
Fairfax City	11,496	75.7%	12.0%	0.3%	4.2%	7.8%	92.2%	0.889
Loudoun	87,590	86.0%	10.3%	0.2%	2.1%	1.4%	98.6%	0.926
Pr. William	146,091	74.7%	19.3%	0.3%	2.4%	3.3%	96.7%	0.875
Manassas	23,054	76.5%	17.4%	0.4%	3.1%	2.6%	97.4%	0.879
NOVA region	965,886	73.9%	14.0%	0.3%	2.9%	8.8%	91.2%	0.891

VT/Transit Rider = (DA% + CP%/2 + Taxi & MC%) / (100% - Transit %)

- VMT Reductions: Also using the 2000 Census journey to work data, estimates were made of the average trip length for commute trips for each jurisdiction by compiling information on the distribution of work trip destinations for each jurisdiction. Point-to-point travel distances were then estimated using mapping, and an average VMT calculated as the trip volume weighted average for each jurisdiction. As a result of this process, the average 1-way commute trip length for each jurisdiction is as follows:

Arlington: 6.53 miles
Alexandria: 7.27 miles
Prince William: 14.91 miles
Loudoun County: 15.57 miles
Fairfax County: 14.44 miles
Fairfax City: 7.74 miles
NOVA/Metrobus: 12.95 miles

The average for the entire Northern Virginia region, which is used for Metrobus, is the weighted sum across all the jurisdictions. It should be noted that MWCOG assumes an average trip length of 15.5 miles for all regional commute trips.

With these assumptions in place, Table 46 portrays the number of vehicle trips reduced by the forecast Code Red free fare program for each operator by year of the program. These estimates are the product of the vehicle trip diversion rates calculated in Table 45 times the number of new bus riders on free fare days shown in Table 40.

Table 46 -- Vehicle Trip Reduction

	1999	2000	2001	2002	2003	Total
Arlington	218	0	191	423	283	1,115
DASH	4,974	(72)	5,295	16,331	3,927	30,454
PRTC	(347)	0	2,032	5,256	1,348	8,289
Loudoun	201	0	145	319	180	845
Connector	(9,246)	(326)	(6,427)	(2,425)	1,055	(17,369)
CUE Bus	(1,234)	265	742	415	327	516
WMATA	(52,103)	(5,658)	(112,162)	7,282	28,925	(133,717)
ALL	(57,537)	(5,792)	(110,185)	27,601	36,045	(109,869)
Forecast Code Red Days	8	2	5	12	2	29

Also using the stated assumptions, Table 47 summarizes the VMT change associated with these diverted trips using the average commute trip VMT estimates shown at the bottom of the table. Clearly, what these data show are negative vehicle trip and VMT reduction performance for the first three years of the program, given that many of the systems did not record ridership gains for these periods. However, by 2002 and 2003, as reported ridership, and hence performance, improved, the program is showing net vehicle trip and VMT reductions.

Table 47 -- VMT Reduction by Individual System

	1999	2000	2001	2002	2003	Total
Arlington	1,425	0	1,247	2,761	1,848	7,282
DASH	36,158	(524)	38,493	118,723	28,548	221,399
PRTC	(5,166)	0	30,293	78,369	20,091	123,587
Loudoun	3,129	0	2,264	4,960	2,797	13,149
Connector	(133,514)	(4,712)	(92,812)	(35,010)	15,234	(250,815)
CUE Bus	(9,551)	2,050	5,746	3,213	2,532	3,991
WMATA	(674,739)	(73,277)	(1,452,504)	94,299	374,584	(1,731,637)
ALL	(782,257)	(76,463)	(1,467,274)	267,316	445,634	(1,613,044)
Forecast Code Red Days	8	2	5	12	2	29

Assumed VMT per work trip (one-way): Arlington = 6.53 miles; Alexandria = 7.27 miles; PRTC = 14.91 miles; Loudoun = 15.57 miles; Connector = 14.44 miles, CUE = 7.74 miles and WMATA = 12.95 miles

In Table 48 and Table 49 these estimated vehicle trip and VMT reductions are translated into equivalent emissions reductions for VOCs and NOx, respectively, using the formulae shown under each table. VOCs and NOx are the two primary vehicle-related pollutants that are the precursors to ozone and smog. This formula credits emissions reductions separately for VMT reductions and vehicle trip reductions (VTR), to account

for the importance of vehicle "cold starts", when excess emissions occur each time a vehicle is used, independent of how far it is driven. These formulae use grams-per-mile emissions factors for VOC and NOx that have been adopted by the Metropolitan Washington Council of Governments and used in the region's 2002 transportation conformity analysis.

Table 48 -- VOC Emission Reductions (tons)

	1999	2000	2001	2002	2003	Total
Arlington	0.00142	0.00000	0.00124	0.00275	0.00184	0.00726
DASH	0.03399	(0.00049)	0.03618	0.11159	0.02683	0.20810
PRTC	(0.00352)	0.00000	0.02063	0.05337	0.01368	0.08416
Loudoun	0.00210	0.00000	0.00152	0.00333	0.00188	0.00882
Connector	(0.09199)	(0.00325)	(0.06395)	(0.02412)	0.01050	(0.17282)
CUE Bus	(0.00868)	0.00186	0.00522	0.00292	0.00230	0.00363
WMATA	(0.48466)	(0.05263)	(1.04332)	0.06773	0.26906	(1.24382)
ALL	(0.55135)	(0.05451)	(1.04247)	0.21758	0.32609	(1.10466)
Forecast Code Red Days	8	2	5	12	2	29

Table 49 -- NOx Emissions Reductions (tons)

	1999	2000	2001	2002	2003	Total
Arlington	0.00161	0.00000	0.00141	0.00313	0.00209	0.00824
DASH	0.04011	(0.00058)	0.04270	0.13169	0.03167	0.24559
PRTC	(0.00519)	0.00000	0.03046	0.07880	0.02020	0.12426
Loudoun	0.00313	0.00000	0.00227	0.00497	0.00280	0.01317
Fairfax Connector	(0.13467)	(0.00475)	(0.09362)	(0.03531)	0.01537	(0.25299)
CUE Bus	(0.01048)	0.00225	0.00630	0.00352	0.00278	0.00438
WMATA	(0.68852)	(0.07477)	(1.48217)	0.09623	0.38223	(1.76700)
ALL	(0.79401)	(0.07786)	(1.49265)	0.28302	0.45714	(1.62435)
Forecast Code Red Days	8	2	5	12	2	29

NOx = ((1.337 g/mi x VTR)+(0.8233 g/mi x VMTR))/(454g/lb x 2000 lb/ton))

Table 50 sums the total tons of reduction associated with both VOC and NOx to yield a net reduction of ozone-precursor pollutants. Disregarding the concerns regarding data quality for the first 3 (even 4) years of the program, the reduction estimated for 2003 totals 0.78 ton for the 2 days of deployment in June 2003, or about 0.4 ton per day.

From a perspective of magnitude, this may be regarded as a meaningful emissions reduction for a single strategy. Measures capable of reducing 1 ton per day are of definite interest in regional emission management efforts, and many regional conformity efforts are comprised of numerous measures producing 0.1 tons/day or less. What is especially relevant about this strategy is that it delivers its emission reduction benefit on those days when a pollution alert is in effect, and there is a chance that the federal EPA 1-hour standard for ozone concentrations may be exceeded. Since a region's air quality nonattainment status – and hence, its air quality mitigation efforts – are tied to the number of annual exceedances, strategies whose purpose is to reduce additional emissions during these "spikes" have a particular value in a region's air quality management program.

	1999	2000	2001	2002	2003	Total
Arlington	0.00304	0.00000	0.00265	0.00588	0.00394	0.01551
DASH	0.07410	(0.00107)	0.07888	0.24329	0.05850	0.45369
PRTC	(0.00871)	0.00000	0.05109	0.13217	0.03388	0.20843
Loudoun	0.00523	0.00000	0.00378	0.00829	0.00468	0.02198
Fairfax Connector	(0.22667)	(0.00800)	(0.15757)	(0.05944)	0.02586	(0.42581)
CUE Bus	(0.01916)	0.00411	0.01153	0.00645	0.00508	0.00801
WMATA	(1.17318)	(0.12741)	(2.52548)	0.16396	0.65129	(3.01082)
ALL	(1.34535)	(0.13237)	(2.53512)	0.50060	0.78323	(2.72901)
Forecast Code Red Days	8	2	5	12	2	29

Table 50 -- Total Emissions Reductions in tons (VOC + NOx)

The practical evaluation question then becomes one of cost. What is the cost for this 0.4-ton daily reduction, and how does that cost compare to alternative strategies? To make this assessment, the reductions in Table 50 are compared to the amounts paid to the bus operators in compensation of their "lost revenues" for forecast Code Red Day operations, as shown in Table 51.

Table 51 -- Program Cost Outlay ("Lost Revenue") by Individual System

	1999	2000	2001	2002	2003	Total
Arlington	$661	$0	$290	$9,357	$4,774	$15,082
DASH	$26,549	$3,167	$24,444	$63,175	$12,428	$129,763
PRTC	$36,304	$0	$65,382	$157,424	$35,822	$294,932
Loudoun	$10,944	$0	$16,367	$38,447	$12,019	$77,777
Fairfax Connector	$26,737	$2,295	$36,347	$73,069	$17,051	$155,499
CUE Bus	$2,072	$208	$2,285	$4,778	$914	$10,257
WMATA	$193,194	$15,262	$186,340	$324,308	$57,307	$776,411
ALL	$296,460	$20,932	$331,455	$670,558	$140,315	$1,459,720
Forecast Code Red Days	8	2	5	12	2	29

Dividing the Table 51 costs by the Table 50 emission reductions produces the effective cost-per-ton shown in Table 52. The cost per ton performance displayed in Table 52 suggests that by the time the forecast Code Red Day free bus fare program has reached 2003, the cost of reduction for the program as a whole has reached an average of $179,149/ton, based on the total funding outlay of $140,315 for the two June 2003 episodes. However, what must be noted is that the performance of the two largest operators, Metrobus and Fairfax Connector, which account for 62.3% and 20.2%, respectively, of the 2.56 million riders who would have been carried on the 29 forecast Code Red Days between 1999 and 2003, clearly dominates the overall picture of program performance. As Metrobus's performance has improved by 2003, to where its reduction is in the range of $88,000 per ton, the entire program begins to move toward a level where reasonable assessments of its merit can begin. However, even as the improvement in Metrobus ridership begins to color the overall program's picture more positively, this then draws attention to the performance of not just the number 2 system – Fairfax Connector ($659,000/ton) – but many of the smaller systems, which are averaging costs greater than that of the Fairfax Connector. Of particular note are PRTC

at $1.057 million/ton, Arlington at $1.2 million/ton, and Loudoun County at $2.6 million/ton. Even though these other systems receive small amounts of program funding relative to Metrobus and Connector, their comparatively high costs per ton should not be ignored.

Table 52 -- Cost per Ton Reduced

	1999	2000	2001	2002	2003	Total
Arlington	$217,767	NA	$109,222	$1,591,250	$1,213,037	$972,669
DASH	$358,301	($2,950,736)	$309,887	$259,672	$212,441	$286,015
PRTC	($4,166,729)	NA	$1,279,770	$1,191,103	$1,057,219	$1,415,045
Loudoun	$2,092,294	NA	$4,324,897	$4,636,714	$2,570,236	$3,538,040
Fairfax Connector	($117,955)	($286,865)	($230,675)	($1,229,354)	$659,298	($365,183)
CUE Bus	($108,138)	$50,562	$198,234	$741,154	$179,919	$1,281,065
WMATA	($164,676)	($119,788)	($73,784)	$1,977,980	$87,990	($257,874)
ALL	($220,358)	($158,135)	($130,745)	$1,339,520	$179,149	($534,889)
Forecast Code Red Days	8	2	5	12	2	29

Conversations with air quality staff at MWCOG could not confirm whether an emissions strategy with the performance of the forecast Code Red Day free bus fare program would or would not be attractive at a current cost of $179,000 per ton. Obviously, much depends upon (1) how dire the need is for emissions reductions at any given time given conformity or ozone exceedance considerations, and (2) what other strategies are available for use and their comparative cost. MWCOG staff have made it clear that when emissions strategies such as the forecast Code Red Day free fare program are considered for adoption, more criteria are applied to that determination than just cost per ton. Political acceptability, type of pollutant, ease of administration, and scale of reduction are all used in gauging an effective strategy. Also important is the fact that the forecast Code Red Day free fare program is strategic as an “episodic” control measure, i.e., it is brought into play on days when ozone exceedances are anticipated, and when additional efforts are necessary to try to avert an exceedance of the 1-hour standard.

The most direct comparison of the forecast Code Red Day free fare program with other current regional efforts would be MWCOG’s Commuter Connections program. This program, which consists of six separate elements, has also been operating since 1999. Its travel and emissions reduction performance, as gleaned from the FY2004 Work Program, is summarized in Table 53 below. If these results are accepted as accurate, then the Commuter Connections program is delivering emissions reductions at a cost of about $5,000/ton, which is obviously much more cost effective than the current Code Red Free Fare program.

Table 53 – MWCOG Commuter Connections Program

Average Daily Travel and Emissions Impacts for 2002

Program	Daily Vehicle Trip Reduction	Daily VMT Reduction	Reduction (tons per day) VOC	NOx	Total	FY 2003 Budget	Average Daily Cost (250 days)	Cost per Ton
Telework Resource Ctr.	12,590	279,692	0.195	0.389	0.584	$780,000	$3,120	$5,342
Guaranteed Ride Home	6,803	229,276	0.119	0.276	0.395	$1,678,500	$6,714	$16,997
Integrated Rideshare	3,418	117,940	0.074	0.159	0.233	$177,000	$708	$3,039
Employer Outreach	71,267	1,107,698	0.755	1.473	2.228	$1,161,150	$4,645	$2,085
Bicycle Outreach	284	1,225	0.002	0.002	0.004	$15,000	$60	$15,000
Commuter Ops Ctr.	1,970	66,056	0.034	0.079	0.113	$552,400	$2,210	$19,554
Total	96,332	1,801,887	1.179	2.378	3.557	$4,364,050	$17,456	$4,908

Source: Commuter Connections FY2003 Work Program, March 2003

Another way of assessing the reasonableness or relative attractiveness of the forecast Code Red Day free bus fare program is to compare its performance with national experience. For this, the CMAQ program evaluation performed by the Transportation Research Board for Congress in 2002 offers a good sampling of measures used around the country over the past 10 years[1]. However, to compare the Code Red program with the TRB studies, it is first necessary to "weight" the emission reductions in the manner that the TRB committee elected to do for the purpose of magnifying the importance of NOx reductions over VOCs. Because NOx reductions have been historically more difficult to come by in air quality management efforts, they have generally been regarded at a premium when comparing strategies, particularly since some strategies have a comparative advantage in reducing NOx over VOCs. To reflect this, the TRB committee, comprised of State, MPO and academic/research air quality specialists from around the country, agreed to weight NOx emissions at 4 times the value of VOCs. To be able to compare the Code Red program with these national studies, Table 54 and Table 55 show the results of this weighting scheme.

[1] The Congestion Mitigation and Air Quality Program: Assessing 10 Years of Experience. Special Report No. 264, Transportation Research Board, Washington (2002).

Table 54 -- Total Emissions Reductions @ 4:1 NOx:VOC Weighting

	1999	2000	2001	2002	2003	Total
Arlington	0.00788	0.00000	0.00689	0.01526	0.01021	0.04024
DASH	0.19442	(0.00282)	0.20698	0.63837	0.15350	1.19046
PRTC	(0.02430)	0.00000	0.14247	0.36856	0.09449	0.58122
Loudoun	0.01463	0.00000	0.01058	0.02319	0.01308	0.06148
Fairfax Connector	(0.63069)	(0.02226)	(0.43842)	(0.16538)	0.07196	(1.18479)
CUE Bus	(0.05059)	0.01086	0.03043	0.01702	0.01341	0.02114
WMATA	(3.23873)	(0.35173)	(6.97199)	0.45263	1.79799	(8.31182)
ALL	(3.72738)	(0.36594)	(7.01306)	1.34966	2.15465	(7.60208)
Forecast Code Red Days	8	2	5	12	2	29

(total tons = 1 x VOC tons + 4 x NOx tons)

Table 55 -- Cost per Ton Reduced @ 4:1 NOx:VOC Weighting

Arlington	$83,915	NA	$42,088	$613,177	$467,435	$374,811
DASH	$136,551	($1,124,546)	$118,100	$98,963	$80,963	$109,002
PRTC	($1,494,199)	NA	$458,929	$427,132	$379,121	$507,439
Loudoun	$748,117	NA	$1,546,403	$1,657,896	$919,009	$1,265,056
Fairfax Connector	($42,393)	($103,098)	($82,904)	($441,825)	$236,949	($131,245)
CUE Bus	($40,956)	$19,150	$75,079	$280,704	$68,142	$485,190
WMATA	($59,651)	($43,391)	($26,727)	$716,490	$31,873	($93,410)
ALL	($79,536)	($57,200)	($47,263)	$496,835	$65,122	($192,016)
Forecast Code Red Days	8	2	5	12	2	29

- Using this approach, the Code Red Free Fare program is reducing an average of 1.1 combined tons per day in 2003, and costs an average of $65,122 per ton. Metrobus under these circumstances is reducing emissions at a cost of $31,873 per ton. As indicated by the cost ranges displayed in Table 56, the $65,122 per ton for the overall program, and the $31,873 per ton for Metrobus, fit well within the range of performance of most of the strategies investigated in the TRB study. Among the 139 strategies reviewed by the TRB study, the Northern Virginia forecast Code Red Day free bus fare program would fall in the upper third of the cost-per-ton distribution, with about 65% of strategies costing less per ton. Metrobus performance would fall about at the mid-point, with about half of the TRB strategies costing less.

  Strategies in the TRB national study that performed better as a group than the Northern Virginia forecast Code Red Day free bus fare strategy included Inspection & Maintenance programs (median of $1,900 per ton), Regional Ridesharing programs ($7,400/ton), Vanpool programs ($10,500/ton), Alternative Fuel Vehicles ($17,800/ton), Traffic Signalization ($20,100/ton), Conventional Transit Service Improvements ($24,600/ton), and Employer Trip Reduction programs ($22,700/ton). Strategies in the national study that performed the same or more poorly included Transit Capital Improvements/Vehicle Replacements ($66,400/ton), Bicycle/Pedestrian Facilities ($84,100/ton), New Transit Shuttles or Feeder Lines ($87,500/ton), Freeway Incident Management ($102,400/ton), Alternative Fuel Buses ($126,400/ton), HOV Lanes ($176,200/ton), and Telecommute/Telework ($251,800/ton).

Table 56 – Range of Cost Effectiveness of CMAQ-Funded Emissions Reduction Strategies
(@ VOC:NOx weighting of 1:4)

	Number of Cases	Cost per Ton Range		Median	FY92-98 CMAQ Obligations
		Low	High		
Traffic Flow Improvements					**34.9%**
Signalization	5	$6,000	$128,000	$20,100	9.3%
Freeway/Incident Management	4	$2,300	$543,900	$102,400	7.5%
HOV Facilities	2	$15,700	$336,800	$176,200	5.2%
Intersections, Traveler Info, Other	0	NA	NA	NA	12.9%
Group Average		$6,418	$317,200	$99,567	
Ridesharing					**4.0%**
Regional Rideshare	5	$1,200	$1,600	$7,400	2.4%
Vanpool Programs	6	$5,200	$89,000	$10,500	
Park & Ride Lots	4	$8,600	$70,700	$43,000	1.6%
Group Average		$4,773	$54,987	$20,300	
Travel Demand Management					**3.0%**
Misc. TDM	9	$2,300	$33,200	$12,500	2.2%
Employer Trip Reduction	7	$5,799	$175,500	$22,700	0.8%
Group Average		$3,831	$95,456	$17,600	
Telework					**0.0%**
All	10	$13,300	$8,227,000	$251,800	
Bike/Pedestrian					**3.3%**
All	14	$4,200	$344,700	$84,100	3.3%
Transit Improvements					**42.2%**
Shuttles, Feeder, Paratransit	15	$12,300	$1,974,000	$87,500	7.4%
New Capital Systems/Vehicles	6	$8,500	$470,800	$66,400	10.4%
Conventional Service Upgrades	10	$3,800	$99,800	$22,100	7.4%
Park & Ride Lots	1	$52,000	$52,000	$52,000	1.3%
Group Average		$10,172	$1,046,400	$57,000	
Other					**6.8%**
Conventional Fuel Vehicles	6	$400	$39,900	$15,000	12.4%
Alternative Fuel Buses	11	$6,700	$568,700	$126,400	3.3%
Alternative Fuel Vehicles	2	$4,000	$31,600	$17,800	0.8%
Inspection & Maintenance	5	$4,426	$5,800	$1,900	2.9%
Group Average		$4,426	$274,471	$40,275	
Pricing Measures					**0.0%**
Modal Subsidies & Vouchers	14	$800	$471,000	$46,600	
Charges and Fees	6	$800	$49,400	$10,300	
Group Average		$800	$344,520	$28,450	

Source: Transportation Research Board Special Report 264. *The Congestion Mitigation and Air Quality Improvement Program: Assessing 10 Years of Experience.* Table 4-2. (2002).

Program Assessment

Program Costs

Given the apparent trends in ridership on forecast Code Red Days, and with concerns that the data would say that ridership losses on forecast Code Red Days occurred in spite of the free fares in the first years of the program, an important evaluation question is in the cost-effectiveness of the program in attracting riders and – ultimately – in reducing VMT and vehicle emissions.

Table 57 summarizes the "lost revenue" estimates from each operator for the respective year of program. Note that amounts differ greatly from year to year because of the different number of forecast Code Red Days in each, as well as differences in fare level from year to year.

Table 57 -- Program Cost Outlay ("Lost Revenue") by Individual System

	1999	2000	2001	2002	2003	Total
Arlington	$661	$0	$290	$9,357	$4,774	$15,082
DASH	$26,549	$3,167	$24,444	$63,175	$12,428	$129,763
PRTC	$36,304	$0	$65,382	$157,424	$35,822	$294,932
Loudoun	$10,944	$0	$16,367	$38,447	$12,019	$77,777
Fairfax Connector	$26,737	$2,295	$36,347	$73,069	$17,051	$155,499
CUE Bus	$2,072	$208	$2,285	$4,778	$914	$10,257
WMATA	$193,194	$15,262	$186,340	$324,308	$57,307	$776,411
ALL	$296,460	$20,932	$331,455	$670,558	$140,315	$1,459,720
Forecast Code Red Days	8	2	5	12	2	29

Program Effects

The effects of the free far program remain uncertain. The boarding count data supplied by the operators report lower ridership on forecast Code Red Days than on typical days, but whether these counts are spurious or if the declines in ridership are less than would have occurred absent the free fare program cannot be determined. What can be said is that in the two most recent years reported bus ridership on forecast Code Red Days has, on average, been greater than on typical days and the number of incremental riders per day seems to be increasing.

Table 58 -- Ridership Change by Individual System

	1999	2000	2001	2002	2003	Total
Arlington	263	0	230	510	341	1,344
DASH	5,730	(83)	6,100	18,814	4,524	35,085
PRTC	(396)	0	2,322	6,007	1,540	9,473
Loudoun	217	0	157	344	194	912
Fairfax Connector	(10,228)	(361)	(7,110)	(2,682)	1,167	(19,214)
CUE Bus	(1,388)	298	835	467	368	580
WMATA	(58,609)	(6,365)	(126,167)	8,191	32,537	(150,413)
ALL	(64,411)	(6,511)	(123,633)	31,651	40,671	(122,234)
Forecast Code Red Days	8	2	5	12	2	29

Assessment

The lost revenue estimates were compared with the estimated increase in ridership on forecast Code Red Days in Table 58. Dividing Table 57's Revenue by Table 58's ridership leads to an estimated cost per added passenger, as shown in Table 59.

Table 59 -- Cost per Additional Passenger

	1999	2000	2001	2002	2003	Total
Arlington	$2.51	NA	$1.26	$18.37	$14.00	$11.23
DASH	$4.63	($38.16)	$4.01	$3.36	$2.75	$3.70
PRTC	($91.68)	NA	$28.16	$26.21	$23.26	$31.13
Loudoun	$50.43	NA	$104.25	$111.76	$61.95	$85.28
Fairfax Connector	($2.61)	($6.36)	($5.11)	($27.24)	$14.61	($8.09)
CUE Bus	($1.49)	$0.70	$2.74	$10.23	$2.48	$17.68
WMATA	($3.30)	($2.40)	($1.48)	$39.59	$1.76	($5.16)
ALL	($4.60)	($3.21)	($2.68)	$21.19	$3.45	($11.94)
Forecast Code Red Days	8	2	5	12	2	29

The patterns shown in Table 59 strongly reflect the impact of substantially lower reported ridership on forecast Code Red Days (real or on paper) among (principally) Metrobus and Fairfax Connector over the first four years, leading to the perverse result that the $9.71 cost per passenger for the program per date indicates "the cost per rider lost". However, the positive trends in program ridership after 2001 are reflected in, first, a cost per new rider of $21.19 in 2002 – which is at least positive –and a cost of $3.45 per new rider in 2003.

Looking across the operators, generally the best operations – as of 2003 -- are Metrobus at $1.76 per rider, CUE Bus at $2.48 per rider, and Alexandria at $2.75 per rider. All of the rest are considerably more costly: Arlington is attracting riders at a rate of $14.00 per rider, the Fairfax Connector is costing $14.61 per rider, PRTC is costing $23.26 per rider, and Loudoun Transit is the most expensive of all at $61.95 per additional rider. This reflects the fact that most of the benefits of the free fare program are received by regular bus passengers – those whose decision to use the bus is not mandated by the free fare. The highest costs per incremental passenger are for those systems that

charge the highest fares (e.g. PRTC, Loudoun Transit) and those that have low rates of use of monthly or weekly passes. Note that passengers who hold time-limited passes receive no benefit from the free fare program and the operating agency suffers no loss of revenue related to these passengers.

An initial hypothesis was that systems with generally long trips and high fares – particularly PRTC and Loudoun – might be more effective because riders would save much more on free fare days. In fact, both systems have shown consistent ridership gains for all years they have participated in the program. However, the high fares that attract riders also lead to high lost revenues. As a result, these have turned out to be the two least cost-effective systems.

Metrobus, CUE, and Alexandria have become more cost effective over time, while Arlington has gotten less cost effective. PRTC and Loudoun started at a high cost per rider and have remained high. The Fairfax Connector has only recently emerged from showing net ridership losses through 2002, and in this first year of positive results is averaging $14.61 per rider.

Recommendations

Using the bus ridership data available from NVTC and estimates of travel patterns for commuters in Northern Virginia from the Metropolitan Washington Council of Governments, a preliminary evaluation of the effectiveness of the program has been developed. This evaluation reveals that that the free fare program, after a slow start, does seem to be attracting additional bus riders of free fare days and, as a result, contributing to a small but significant reduction in the emissions on the days when exceedances of air quality standards in projected. The cost per ton of pollutant removed for these reductions is greater than some of the other measures already in place, but in line with the costs found in other programs and in other metropolitan areas.

There are signs that that ridership data collection on the free fare days is improving. Reported passenger counts for the later days in 2002 and the days in 2003 seem more in line with the variation that would be expected. This may also be coupled with greater public awareness of both the program and the need for special actions on Ozone Alert Days. A broader issue is the validity of the boarding counts. For these two largest systems the standard deviation in reported ridership is 10% to 15% of the mean. For the other systems the ratio is 3% to 4%. Further investigation of the typical ridership patterns and of the mechanisms used to gather and report ridership are needed to fully understand the effects of free fare on forecast Code Red Days.

The recommended action - continuation of the study through 2004 - would likely provide opportunities to determine if the trend toward reported ridership increases on free fare days continues and to collect on-board survey data so that characteristics of attracted riders can be determined. A program to assess the normal variation in daily ridership counts and to improve passenger counting on free fare days is also recommended.

Appendix A – Forecast Code Red Day Ridership by System

Forecast Code Red Date	Day of Week	Arlington Acutal	Arlington 3-wk avg	Arlington Gain	Arlington % Change	Alexandria Acutal	Alexandria 3-wk avg	Alexandria Gain	Alexandria % Change
5/30/1999	Sunday					2029	1968	61	3%
6/7/1999	Monday	378	420	-42	-10%	9383	8369	1014	12%
6/8/1999	Tuesday	570	442	128	29%	9753	8793	960	11%
7/17/1999	Saturday					4175	3876	299	8%
7/18/1999	Sunday					2315	2020	295	15%
7/19/1999	Monday	572	454	118	26%	9820	8455	1365	16%
7/30/1999	Friday	522	463	59	13%	10063	9080	983	11%
7/31/1999	Saturday					4510	3757	753	20%
		2,042	**1,779**	**263**	**15%**	**52,048**	**46,318**	**5,730**	**12%**
6/10/2000	Saturday					3849	3813	36	1%
6/11/2000	Sunday					1934	2053	-119	-6%
		0	**0**	**0**		**5,783**	**5,866**	**-83**	**-1%**
6/27/2001	Wednesday	483	451	32	7%	10953	9848	1105	11%
6/28/2001	Thursday	461	442	19	4%	11083	9751	1332	14%
6/29/2001	Friday	416	390	26	7%	11530	9604	1926	20%
8/8/2001	Wednesday	624	494	130	26%	10889	10126	763	8%
8/9/2001	Thursday	227	204	23	11%	10951	9977	974	10%
		2,211	**1,981**	**230**	**12%**	**55,406**	**49,306**	**6,100**	**12%**
6/11/2002	Tuesday	1390	1044	345.7	33%	11163	9583	1580	16%
6/24/2002	Monday	1238	1017	220.7	22%	11212	9643	1569	16%
6/25/2002	Tuesday	1198	977	221	23%	11391	9646	1745	18%
7/3/2002	Wednesday	736	1010	-274	-27%	12580	9644	2936	30%
7/17/2002	Wednesday	1250	1106	143.7	13%	12520	10172	2348	23%
8/2/2002	Friday	1141	1125	16	1%	11755	10484	1271	12%
8/3/2002	Saturday	168	250	-82	-33%	4991	3914	1077	28%
8/5/2002	Monday	1186	1240	-54	-4%	12253	10712	1541	14%
8/11/2002	Sunday	161	130	30.7	24%	2912	2283	629	28%
8/12/2002	Monday	1231	1240	-9.3	-1%	11776	10712	1064	10%
8/13/2002	Tuesday	1258	1283	-25	-2%	12092	10792	1300	12%
8/14/2002	Wednesday	1230	1254	-24	-2%	12359	10605	1754	17%
		12,187	**11,678**	**510**	**4%**	**127,004**	**108,190**	**18,814**	**17%**
6/25/2003	Wednesday	2305	2141	164	8%	12757	10444	2313	22%
6/26/2003	Thursday	2376	2199	177	8%	12832	10621	2211	21%
		4,681	**4,340**	**341**	**8%**	**25,589**	**21,065**	**4,524**	**21%**
1999-2003 Total		**21,121**	**19,778**	**1,344**	**7%**	**265,830**	**230,745**	**35,085**	**15%**
2002-2003 Total		**16,868**	**16,018**	**851**	**5%**	**152,593**	**129,255**	**23,338**	**18%**

Forecast Code Red Date	Day of Week	Fairfax Connector Acutal	Fairfax Connector 3-wk avg	Fairfax Connector Gain	Fairfax Connector % Change	CUE Actual	CUE 3-wk avg	CUE Gain	CUE % Change
5/30/1999	Sunday								
6/7/1999	Monday	16330	17449	-1119	-6%	2139	3160	-1021	-32%
6/8/1999	Tuesday	16843	18853	-2010	-11%	3175	3160	15	0%
7/17/1999	Saturday	3416	4462	-1046	-23%	917	939	-22	-2%
7/18/1999	Sunday	1063	2614	-1551	-59%	538	476	62	13%
7/19/1999	Monday	15079	16938	-1859	-11%	2658	3160	-502	-16%
7/30/1999	Friday	15560	17519	-1959	-11%	3269	3160	109	3%
7/31/1999	Saturday	3650	4334	-684	-16%	910	939	-29	-3%
		71,941	**82,169**	**-10,228**	**-12%**	**13,606**	**14,994**	**-1,388**	**-9%**
6/10/2000	Saturday	3909	4742	-833	-18%	1060	939	121	13%
6/11/2000	Sunday	3209	2737	472	17%	653	476	177	37%
		7,118	**7,479**	**-361**	**-5%**	**1,713**	**1,415**	**298**	**21%**
6/27/2001	Wednesday	17133	22990	-5857	-25%	3462	3160	302	10%
6/28/2001	Thursday	20304	22830	-2526	-11%	3401	3160	241	8%
6/29/2001	Friday	22566	20364	2202	11%	3263	3160	103	3%
8/8/2001	Wednesday	23251	22927	324	1%	3309	3160	149	5%
8/9/2001	Thursday	23262	24515	-1253	-5%	3200	3160	40	1%
		106,516	**113,626**	**-7,110**	**-6%**	**16,635**	**15,800**	**835**	**5%**
6/11/2002	Tuesday	24650	24035	615	3%	3728	3346	382	11%
6/24/2002	Monday	20928	28107	-7179	-26%	3463	3346	117	3%
6/25/2002	Tuesday	27360	23194	4166	18%	3463	3346	117	3%
7/3/2002	Wednesday	21153	23295	-2142	-9%	3116	3346	-230	-7%
7/17/2002	Wednesday	25345	24133	1212	5%	3285	3396	-111	-3%
8/2/2002	Friday	24352	23342	1010	4%	3000	3160	-160	-5%
8/3/2002	Saturday	6299	7470	-1171	-16%	1051	939	112	12%
8/5/2002	Monday	23966	25310	-1344	-5%	3006	3160	-154	-5%
8/11/2002	Sunday	4639	5034	-395	-8%	647	476	171	36%
8/12/2002	Monday	24032	25531	-1499	-6%	3093	3160	-67	-2%
8/13/2002	Tuesday	26140	25340	800	3%	3376	3160	216	7%
8/14/2002	Wednesday	28830	25585	3245	13%	3234	3160	74	2%
		257,694	**260,376**	**-2,682**	**#REF!**	**34,462**	**33,995**	**467**	**1%**
6/25/2003	Wednesday	27142	23860	3282	14%	3521	3160	361	11%
6/26/2003	Thursday	27788	29903	-2115	-7%	3167	3160	7	0%
		54,930	**53,763**	**1,167**	**2%**	**6,688**	**6,320**	**368**	**6%**
1999-2003 Total		**498,199**	**517,413**	**-19,214**	**-4%**	**73,104**	**72,524**	**580**	**1%**
2002-2003 Total		**312,624**	**314,139**	**-1,515**	**-0.5%**	**41,150**	**40,315**	**835**	**2%**

Forecast Code Red Date	Day of Week	PRTC Actual	PRTC 3-wk avg	PRTC Gain	PRTC % Change	Loudoun Actual	Loudoun 3-wk avg	Loudoun Gain	Loudoun % Change
5/30/1999	Sunday								
6/7/1999	Monday	3084	3565	-481	-13%	752	711	41	6%
6/8/1999	Tuesday	3398	3589	-191	-5%	781	712	69	10%
7/17/1999	Saturday								
7/18/1999	Sunday								
7/19/1999	Monday	3777	3449	328	10%	767	692	75	11%
7/30/1999	Friday	3552	3604	-52	-1%	653	621	32	5%
7/31/1999	Saturday								
		13,811	**14,207**	**-396**	**-3%**	**2,953**	**2,736**	**217**	**8%**
6/10/2000	Saturday								
6/11/2000	Sunday								
		0	**0**	**0**		**0**	**0**	**0**	
6/27/2001	Wednesday	5671	5382	289	5%	912	868	44	5%
6/28/2001	Thursday	5805	5240	565	11%	897	839	58	7%
6/29/2001	Friday	5281	4884	397	8%	776	736	40	5%
8/8/2001	Wednesday	6419	5836	583	10%	832	838	-6	-1%
8/9/2001	Thursday	5896	5408	488	9%	832	811	21	3%
		29,072	**26,750**	**2322**	**9%**	**4,249**	**4,092**	**157**	**4%**
6/11/2002	Tuesday	7040	6300	740	12%	914	948	-34	-4%
6/24/2002	Monday	6985	6398	587	9%	995	916	79	9%
6/25/2002	Tuesday	7476	6733	743	11%	1066	979	87	9%
7/3/2002	Wednesday	7016	6831	185	3%	926	980	-54	-6%
7/17/2002	Wednesday	7700	6836	864	13%	1000	984	16	2%
8/2/2002	Friday	6864	5993	871	15%	820	788	32	4%
8/3/2002	Saturday								
8/5/2002	Monday	6915	6909	6	0%	1077	998	79	8%
8/11/2002	Sunday								
8/12/2002	Monday	7360	6909	451	7%	1008	1039	-31	-3%
8/13/2002	Tuesday	7749	7235	514	7%	1064	976	88	9%
8/14/2002	Wednesday	8080	7034	1046	15%	1084	1002	82	8%
		73,185	**67,178**	**6007**	**9%**	**9,954**	**9,610**	**344**	**4%**
6/25/2003	Wednesday	8086	7414	672	9%	1542	1454	88	6%
6/26/2003	Thursday	8408	7540	868	12%	1506	1400	106	8%
		16,494	**14,954**	**1540**	**10%**	**3,048**	**2,854**	**194**	**7%**
1999-2003 Total		**132,562**	**123,089**	**9473**	**8%**	**20,204**	**19,292**	**912**	**5%**
2002-2003 Total		**89,679**	**82,132**	**7547**	**9%**	**13,002**	**12,464**	**538**	**4%**

Forecast Code Red Date	Day of Week	Metrobus Acutal	Metrobus 3-wk avg	Metrobus Gain	Metrobus % Change	All Systems Acutal	All Systems 3-wk avg	All Systems Gain	All Systems % Change
5/30/1999	Sunday					2029	1968	61	3%
6/7/1999	Monday	41156	64944	-23788	-37%	73222	98618	-25396	-26%
6/8/1999	Tuesday	49244	66108	-16864	-26%	83764	101657	-17893	-18%
7/17/1999	Saturday	27040	27913	-873	-3%	35548	37190	-1642	-4%
7/18/1999	Sunday	9845	15552	-5707	-37%	13761	20662	-6901	-33%
7/19/1999	Monday	57617	68994	-11377	-16%	90290	102142	-11852	-12%
7/30/1999	Friday					33619	34447	-828	-2%
7/31/1999	Saturday					9070	9030	40	0%
		184,902	**243,511**	**-58,609**	**-24%**	**341,303**	**405,714**	**-64,411**	**-16%**
6/10/2000	Saturday	23659	30024	-6365	-21%	32477	39518	-7041	-18%
6/11/2000	Sunday					5796	5266	530	10%
		23,659	**30,024**	**-6,365**	**-21%**	**38,273**	**44,784**	**-6,511**	**-15%**
6/27/2001	Wednesday	56113	86414	-30301	-35%	94727	129113	-34386	-27%
6/28/2001	Thursday	50317	75893	-25576	-34%	92268	118155	-25887	-22%
6/29/2001	Friday	58315	71638	-13323	-19%	102147	110776	-8629	-8%
8/8/2001	Wednesday	60948	89512	-28564	-32%	106272	132893	-26621	-20%
8/9/2001	Thursday	64332	92735	-28403	-31%	108700	136810	-28110	-21%
		290,025	**416,192**	**-126,167**	**-30%**	**504,114**	**627,747**	**-123,633**	**-20%**
6/11/2002	Tuesday	70231	84165	-13934	-17%	119116	129421	-10305	-8%
6/24/2002	Monday	60466	93937	-33471	-36%	105287	143364	-38077	-27%
6/25/2002	Tuesday	81069	80287	782	1%	133023	125162	7861	6%
7/3/2002	Wednesday	76520	75592	928	1%	122047	120698	1349	1%
7/17/2002	Wednesday	93773	80259	13514	17%	144873	126886	17987	14%
8/2/2002	Friday	88241	76622	11619	15%	136173	121514	14659	12%
8/3/2002	Saturday	31189	30775	414	1%	43698	43348	350	1%
8/5/2002	Monday	102856	94480	8376	9%	151259	142809	8450	6%
8/11/2002	Sunday	26212	22331	3881	17%	34571	30254	4317	14%
8/12/2002	Monday	105970	94480	11490	12%	154470	143071	11399	8%
8/13/2002	Tuesday	92934	88699	4235	5%	144613	137485	7128	5%
8/14/2002	Wednesday	90241	89884	357	0%	145058	138524	6534	5%
		919,702	**911,511**	**8,191**	**1%**	**1,434,188**	**1,402,538**	**31,651**	**2%**
6/25/2003	Wednesday	94997	74616	20381	27%	150350	123089	27261	22%
6/26/2003	Thursday	86500	74344	12156	16%	142577	129167	13410	10%
		181,497	**148,960**	**32,537**	**22%**	**292,927**	**252,256**	**40,671**	**16%**
1999-2003 Total		**1,599,785**	**1,750,198**	**-150,413**	**-9%**	**2,610,805**	**2,733,039**	**-122,234**	**-4%**
2002-2003 Total		**1,101,199**	**1,060,471**	**40,728**	**4%**	**1,727,115**	**1,654,794**	**72,322**	**4%**

Appendix B - Form for Forcast Code Red Day On-Board Rider Survey

The questions to be asked and the general layout of the on-board survey questionnaire are show on the following pages. The actual printed forms contain all the questions on one side of a single page. The questionnaire in Spanish, (not included here) is printed on the other side of the single page.

AIR QUALITY CODE RED DAY SURVEY

Dear Rider: The Northern Virginia Transportation Commission, in cooperation with the transit agencies operating in Northern Virginia, is conducting this survey to learn more about your travel and how it is affected by the Air Quality Code Red Ozone Action Day (Bad Air Day) alerts. Please complete and return the card to the survey worker. All responses will be kept confidential. ***Thank you for your help!***

If you do not wish to complete the survey we ask that you check here ☐ *and return the card to the survey worker.*

1.a. Prior to boarding the bus, were you aware that today is a BAD AIR DAY? ☐ Yes ☐ No

1.b. If YES, how did you become aware of the BAD AIR DAY alert today? (Please check all that apply)

☐ TV ☐ Radio ☐ Newspaper ☐ Employer Alert ☐ Bus Display ☐ Electronic Highway Sign

☐ E-Mail ☐ Weather Report ☐ Website ☐ Other_____

2.a. Why did you choose to ride the bus today? ☐ I am a regular rider ☐ I wanted to help reduce air pollution

☐ I wanted to avoid the heat ☐ Because of the free fare ☐ Other_____

2.b. How would you have made this same trip if the fare were regular price?

☐ Same Bus ☐ Drive a car ☐ Passenger in a car ☐ Walk ☐ Ride Metrorail ☐ Bicycle

☐ Ride VRE ☐ Ride another bus (what route_____) ☐ Would not have made trip ☐

Other_____

2.c. Would you have taken the bus today if the fare were: (Please check all that apply)

25 cents ☐ Yes ☐ No 35 cents ☐ Yes ☐ No 50 cents ☐ Yes ☐ No

3. Where did you get on this bus? Street_____ Nearest Intersection_____

4.a. Where did you COME FROM before you got on THIS BUS?

Address or Street_____ Nearest intersection_____

4.b. Was this place: ☐ Home ☐ Work ☐ Shopping ☐ School ☐ Other

_____

5.a. Where is your FINAL DESTINATION for this trip?

Address or Street_____ Nearest intersection

_____

5.b. Is this place: ☐ Home ☐ Work ☐ Shopping ☐ School ☐ Other _____

6. How often do you make this trip on the bus?

☐ 6 days a week ☐ 5 days a week ☐ 4 days a week ☐ 3 days a week ☐ 2 days a week ☐ 1 day a week

☐ Every day ☐ First time ☐ Only on Code Red days ☐ Occasionally ☐

Other_____

7. How often do you make this trip by driving?

☐ 6 days a week ☐ 5 days a week ☐ 4 days a week ☐ 3 days a week ☐ 2 days a week ☐ 1 day a week

☐ Every day ☐ Occasionally ☐ Other_____

8. By what other means do you make this same trip? (Please check all that apply)

☐ Passenger in a car ☐ Walk ☐ Ride Metrorail ☐ Bicycle ☐ Ride VRE

☐ Ride another bus (what route_____) ☐ Other_____

9. How did you get to the bus this morning? (Please check all that apply)

☐ Drove a car ☐ Was a passenger in a car ☐ Walked ☐ Rode Metrorail ☐ Bicycled ☐ Rode VRE

☐ Rode another bus (what route_____) ☐ Other_____

10. Did you have a private vehicle available to you to make today's trip? ☐ Yes ☐ No

11. Do you receive MetroCheck? ☐ Yes ☐ No

12.a. Please tell us about you: ☐ Male ☐ Female **12.b.** Age_____ **12.c**. Household Income:_____ per year

12.d. Are you currently employed? ☐ Yes ☐ Part-time ☐ Full-time ☐ No

12.e. Do you consider yourself : ☐ Asian ☐ Black or African American ☐ Hispanic or Latino ☐ White ☐ Other_____

Thank you for your cooperation!

This survey may be mailed back to: NVTC ATTN: CODE RED Survey • 4350 N. Fairfax Drive • Suite 720 • Arlington, VA 22203
If mailing back please identify date, route and time of boarding: Date _____Route_____ Time_____

Appendix C – Telephone Survey Script (with results)

NVTC CODE RED OZONE ALERT DAY SURVEY
SG ASSOCIATES
DECISION DC PROJECT #983
DRAFT #5: 08/14/03

Hi, this is _____ calling on behalf of The Northern Virginia Transportation Commission. We are conducting a very brief survey to learn more about local travel patterns. This is not a sales call and should take less than five minutes.

(IF NECESSARY: This is a genuine survey. No attempt will be made to sell you anything. Your answers will be kept completely confidential and will be used only together with those of other respondents.)

SCREEN1:
For this survey I need to speak with the adult in your household, age 18 or older, who had the most recent birthday. Would that be you?

1 YES-------- SKIP TO Q1
2 NO

SCREEN1A:
May I please speak with the adult in your household, age 18 or older, who had the most recent birthday.

1 YES……WHEN NEW PERSON IS ON THE PHONE, REPEAT INTRO.
2 NOT AT HOME……ARRANGE CALLBACK TIME

1.
Do you commute to work or school?

1 YES	212
2 NO---------SKIP TO Q5	88

2.
On a typical commute, which of the following means of transportation do you use? Do you…
MARK ALL THAT APPLY:

	Mentioned	Primary
Drive a privately owned vehicle	189 (60%)	173 (82%)
Ride as a passenger in a privately owned vehicle	26 (8%)	7 (3%)
Ride Metrorail	42 (13%)	20 (9%)
Ride the Virginia Railway Express commuter train	9 (3%)	4 (2%)
Walk a distance of a half mile or more	25 (8%)	2 (1%)
Ride a bicycle	8 (3%)	1 (0.5%)
Ride a bus - if yes:	**17 (5%)**	**4 (2%)**

What bus system(s) do you ride?

FAIRFAX CONNECTOR	7
METROBUS	7
ALEXANDRIA DASH	3
ARLINGTON TRANSIT	0
LOUDOUN COMMUTER BUS	0
OmniRide/OmniLink	1
CUE BUS	0

OTHER/SPECIFY:_____

[Program caller prompts. If respondent answers with a bus number, the caller should ask, "Which bus system is that? "]

2A.
Do you use any mode of travel that I haven't mentioned during a typical commute?

1 YES----------SPECIFY:_____
2 NO

3.
How many days in a typical week do you commute using the mode(s) you just mentioned?

RECORD # OF DAYS PER WEEK (FOR EACH MODE ANSWERED IN Q2

1_____ 2_____ 3_____

4_____ 5_____ 6_____

7_____ 8_____

4.
Do you do anything differently with regard to your local travel on summer days when you hear or read that air quality is poor?

1 YES	29 (14%)
2 NO---SKIP TO Q5	179 (84%)
Don't Know	4 (2%)
	212 COMMUTERS ONLY

29 Yes

4A.
What do you usually do differently on poor air quality days? MARK ALL THAT APPLY.

7 (24%) CARPOOL
7 (24%) RIDE TRANSIT
4 (14%) WORK FROM HOME/TELECOMMUTE
8 (28%) STAY INDOORS AS MUCH AS POSSIBLE
5 (17%) OTHER: SPECIFY_____

ALL 300 FROM THIS POINT ON

5.
The Washington Metropolitan Council of Governments has a specific name they use to describe a day when it is predicted that ozone levels will be extremely high and air quality very poor. Do you know what those poor air quality days are called?

	Commuters	Non-Commuters
1 CODE RED DAYS----------SKIP TO Q6A	116 (54.7%)	40 (45.5%)
2 OZONE ACTION DAYS ------SKIP TO Q6A	10 (4.7%)	3 (3.4%)
3 BAD AIR DAY OR ALERT	6 (2.8%)	2 (2.3%)
4 OTHER NAME: SPECIFY _____	7 (3.3%)	1 (1.1%)
5 DON'T KNOW/NO ANSWER	73 (34.4%)	42 (47.7%)
	212	88

86 commuters
45 non-commuters

6.
Have you ever heard the term "CODE RED" or "OZONE ACTION DAYS"?

	Commuters	Non-Commuters
1 YES	72 (84%)	30 (67%)
2 NO----SKIP TO Q7	14 (16%)	15 (33%)
	86	45

TOTAL "KNOW " (5-1,2 + 6-1) = 198 (93.4%) + 73 (83%) = 271 (90%)

6A.
What does the term Code Red or Ozone Action Day mean to you?
RECORD ANSWER VERBATIM: **ALL 300 ASKED TO RESPOND**

117 (39%)	Very bad air, unhealthy	62 (21%)	Don't drive	53 (18%)	Hot weather, heat stroke
38 (13%)	Special concerns for old, young, infirm	26 (9%)	Take transit, Carpool	3 (1%)	Change behavior
90 (80%)	Stay indoors, avoid physical activity	27 (9%)	Fuel up after sundown	15 (5%)	Don't Know
		23 (8%)	Don't mow		

7.
Have you ever used the bus, or considered using the bus, on days when the local air quality is predicted to be poor for trips that you would not ordinarily make by bus?

	Commuters	Non-Commuters	All
1 YES	37 (17%)	12 (14%)	49 (16%)
2 NO---SKIP TO Q8.	175 (83%)	76 (86%)	251 (84%)

7A.
Why? RECORD FIRST RESPONSE ONLY.
[49 who considered bus]

	Commuters	Non-C
1 FREE BUS FARE ON CODE RED DAYS ….SKIP TO Q.9	11 (29.7%)	1 (8.3%)
2 TO REDUCE VEHICLE EMISSIONS/HELP ENVIRONMENT	11 (29.7%)	4 (33%)
3 TO AVOID TRAFFIC CONGESTION	2 (5.4%)	3 (25%)
4 FOR HEALTH REASONS	1 (2.7%)	1 (8.3%)
5 TO AVOID THE HEAT	9 (24.3%)	0
6 OTHER/SPECIFY:_____	3 (8.1%)	3 (25%)
	37	12

[37 who did not choose bus because of free fare]
[251 who did not consider bus]
8.
Did you know that bus fares are free on forecasted Code Red Ozone Action Days?

	Commuters	Non-Commuters
1 YES	115 (57.2%)	39 (44.8%)
2 NO/NOT SURE/DON'T KNOW	86 (42.8%)	48 (55.2%)
	201	87

All 300
9.
Does a free bus ride on forecasted Code Red Ozone Action days make you consider taking the bus to make trips that you would not ordinarily make by bus?

	Commuters	Non-Commuters	All
1 YES	85 (40%)	26 (30%)	111 (37%)
2 NO/Don't Know….SKIP TO Q.11	127 (60%)	62 (70%)	189 (63%)

[only 111 who considered taking bus with free fare]
10.
Would you consider taking the bus on forecasted Code Red Ozone Action days if the fare were ½ price?

	Commuters	Non-Commuters	All
1 YES	59 (69%)	22 (85%)	81 (73%)
2 NO/DON'T KNOW	26 (31%)	4 (15%)	30 (27%)
	85	26	111
	86		

11. [ALL 300 ANSWER]
How would you find out when there is a bad air quality alert?

		Commuters	Non-Commuters	All
1	TV	121 (57%)	75 (85%)	196 (65%)
2	Radio	135 (64%)	36 (41%)	171 (57%)
3	Newspaper	24 (11%)	19 (85%)	43 (14%)
4	Employer Alert	6 (3%)	0 (0%)	6 (2%)
5	Bus Display	10 (5%)	2 (2%)	12 (4%)
6	Electronic Highway Sign	27 (13%)	4 (5%)	31 (10%)
7	Email	8 (4%)	2 (2%)	10 (3%)
8	Weather Report	12 (6%)	5 (6%)	17 (6%)
9	Website	18 (8%)	7 (8%)	25 (8%)
10	I can feel it	4 (2%)	0 (0%)	4 (1%)
11	Other_____			

DEMOGRAPHICS:

12 Is public mass transit available for you to use in traveling to and from your place of employment?

	[212 COMMUTERS ONLY]
1 YES	99 (47%)
2 NO	100 (47%)
3 DON'T KNOW	13 (6%)

13. How many private vehicles, including cars, trucks, vans, SUVs, and highway motorcycles are owned or leased by members of your household, and available for everyday use?

Vehicles	Commuters	Non-Commuters	All
0	1 (0.5%)	4 (4.5%)	5 (1.7%)
1	46 (21.7%)	37 (42%)	83 (27.7%)
2	94 (44.3%)	30 (34%)	124 (41.3%)
3	45 (21.2%)	9 (10.2%)	54 (18%)
4+	26 (12.3%)	8 (9.1%)	34 (11.3%)
	212	88	300