Item #3

Transportation Demand Management (TDM) Analysis Report

FY 2021 – FY 2023

Covering the period July 2020 – June 2023

November 21, 2023

COMMUTER CONNECTIONS

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National Capital Region
Transportation Planning Board
COMMUTER CONNECTIONS PROGRAM

Transportation Demand Management (TDM) Analysis Report

FY 2021 – FY 2023
Covering the period July 2020 – June 2023

Prepared for:

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Executive Summary

Background

This report presents the results of an evaluation of four voluntary regional Transportation Demand Management (TDM) program elements implemented by the National Capital Region Transportation Planning Board's (TPB) Commuter Connections program at the Metropolitan Washington Council of Governments (COG). It also documents transportation and air quality impacts generated by the TDM program elements between July 1, 2020 and June 20, 2023. The objective of these elements is to improve the travel experience of regional commuters and support regional efforts to meet air quality goals and mitigate growth in vehicle miles traveled and growth in use of single occupant vehicles. The four TDM program elements covered by this analysis report include:

- **Maryland Telework Assistance** – This TDM program element provides information and assistance to Maryland commuters and employers to further in-home and co-working/telecenter-based teleworking.
- **Guaranteed Ride Home** – Eliminates a barrier to use of alternative modes by providing free rides home in the event of an unexpected personal emergency or unscheduled overtime for commuters who use transit, vanpool, carpool, or bicycles to get to or from work.
- **Employer Outreach** – Provides regional outreach services to encourage large, private-sector and non-profit employers to voluntarily implement commuter assistance strategies that will contribute to reducing vehicle trips to worksites. Includes the efforts of jurisdiction sales representatives to foster new and expanded trip reduction programs. The Employer Outreach for Bicycling component also is part of this analysis.

- **Mass Marketing** – Involves a large-scale, comprehensive media campaign to inform the region's commuters of services available from Commuter Connections as one way to address commuters' frustration about the commute. Various incentive programs and special promotional events also are part of this TDM program element.

COG/TPB's Commuter Connections program is the central administrator of the four program elements noted above. COG also operates the Commuter Connections Commuter Operations Center (COC), providing direct commute assistance services, such as carpool and vanpool matching, transit information, and other information on travel services through telephone and internet assistance to commuters. The COC supports each of the four program elements and is also analyzed for congestion and air quality impacts in this report.

When the TDM program elements were first implemented, COG/TPB staff elected to undertake significant evaluation for each element. The objective of the evaluation process is to provide timely and meaningful information on the performance of each element to decision-makers and other groups, including the TPB and other regional policy makers; COG program funders; Commuter Connections local agency partners; and employers and commuters who comprise Commuter Connections' clients.

This report summarizes the results of the evaluation activities through the Commuter Connections program during the evaluation period and presents the transportation and air quality impacts of the individual program elements and the COC. This evaluation represents a comprehensive evaluation for four program elements and the COC. It should be noted, however, that the evaluation is conservative in the sense that it includes credit only for impacts that can be reasonably documented with accepted measurement methods and tools. Note that many of the calculations use data from surveys, which are subject to some statistical error, at rates common to such surveys.

Additionally, the four program elements and the COC included in the analysis do not encompass all the TDM activities ongoing in the Washington metropolitan region. Many other organizations, such as states and local jurisdictions; transportation management associations; transit agencies, vanpool vendors, and other transportation service providers; employers, commercial and residential building operators, and other public and private organizations also offer services that perform similar functions to the COC and TDM program elements implemented through the Commuter Connections program. The impacts of other TDM services are not addressed in this framework, but certainly are assumed to provide travel and air quality benefits to the region and personal benefits to the commuters who use them.

Summary of Program Element Impacts

The objective of the evaluation is to estimate reductions in vehicle trips (VT), vehicle miles traveled (VMT), and tons of vehicle pollutants (Nitrogen Oxides (NOx), Volatile Organic Compounds (VOC), and Carbon Dioxide (CO2)) resulting from implementation of each TDM program element and compare the impacts against the goals established for the program element. The impact results for these measures are shown in Table A for each program element individually. Results for all elements collectively and for the Commuter Operations Center (COC) are presented in Table B.

As shown in Table A, the four program elements fell about 17% short of the collective goal for vehicle trips reduced and 13% short of the goal for VMT reduced. The program elements did not reach the emission goals; the impact for NOx was 58% under the goal and VOC impact was 41% under the goal, but these deficits were due in part to reductions in the emission factors. The program goals were set in 2006, using 2006 emission factors. Goals for some program elements were re-set after the 2014 and 2017 TDM analyses were conducted but the emission factors used in the 2023 evaluation were considerably lower than the factors from past evaluations, reflecting a cleaner vehicle fleet.

When the COC results are added to the impacts of the four program elements impacts (Table B), the combined impact was 18% below the vehicle trips reduction goal and 20% under the goal for VMT reduced. The combined program element–COC program impact fell 61% short of the NOx goal and was 43% below the VOC goal. Again, the change in the emission factors affected the emission results.

Many factors enter the calculation of impacts, including participation in individual program elements as well as the current and previous commute patterns of program users. Explanations for individual program element results are presented in later sections of the report. But without question, commute disruptions related to the coronavirus pandemic were a significant factor in the overall impact results. As the coronavirus pandemic began, in spring 2020, stay-at-home directives were implemented throughout the Washington metropolitan region, closing many worksites and disrupting typical commutes. Many employees shifted to working from home all or most of their workdays. Additionally, some employees became unemployed or changed jobs, and some who continued commuting to an outside work location changed their commute mode to minimize contact with other commuters.

Table A
Daily Impacts for Individual Program Elements (July 2020 – June 2023) and Comparison to Goals

TDM Program Element	Participation [1]	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Maryland Telework Assistance [2]					
2023 Goal	31,854	11,830	241,209	0.1220	0.0720
Impacts (7/20 – 6/23)	58,961	24,681	489,911	0.1072	0.0898
Net Credit or (Deficit)	**27,107**	**12,851**	**248,702**	**(0.0148)**	**0.0178**
Guaranteed Ride Home					
2023 Goal	18,496	6,296	177,568	0.0890	0.0480
Impacts (7/20 – 6/23)	3,308	2,013	52,201	0.0088	0.0054
Net Credit or (Deficit)	**(15,188)**	**(4,283)**	**(125,367)**	**(0.0802)**	**(0.0426)**
Employer Outreach – all employers participating [3]					
2023 Goal	2,031	90,776	1,533,161	0.6170	0.3850
Impacts (7/20 – 6/23)	2,166	69,498	1,247,480	0.2571	0.2056
Net Credit or (Deficit)	**135**	**(21,278)**	**(285,681)**	**(0.3599)**	**(0.1794)**
Employer Outreach – new / expanded employer services since July 2020 [3]					
2023 Goal	N/A	N/A	N/A	N/A	N/A
Impacts (7/20 – 6/23)	1,177	10,946	198,638	0.0408	0.0325
Net Credit or (Deficit)	N/A	N/A	N/A	N/A	N/A
Employer Outreach for Bicycling [3]					
2023 Goal	590	404	2,421	0.0016	0.0015
Impacts (7/20 – 6/23)	732	405	1,823	0.0007	0.0011
Net Credit or (Deficit)	**142**	**1**	**(598)**	**(0.0009)**	**(0.0004)**
Mass Marketing					
2023 Goal	23,168	10,809	181,932	0.0850	0.0250
Impacts (7/20 – 6/23)	14,501	3,588	65,820	0.0135	0.0108
Net Credit or (Deficit)	**(8,667)**	**(7,221)**	**(116,112)**	**(0.0715)**	**(0.0142)**
TDM Program Elements (all collectively)					
2023 Goal		119,711	2,133,870	0.9130	0.5300
Impacts (7/20 – 6/23)		99,780	1,855,412	0.3866	0.3116
Net Credit or (Deficit)		**(19,931)**	**(278,458)**	**(0.5264)**	**(0.2184)**

1) Participation refers to number of commuters participating, except for the Employer Outreach program element. For this element, participation equals the number of employers participating.

2) Maryland impacts represent portion of regional telework attributable to TW program activities in Maryland. Total telework credited for conformity is higher than reported for the program element.

3) Impacts for Employer Outreach - all employers participating includes impacts for Employer Outreach – new / expanded employer services since July 2020 and for Employer Outreach for Bicycling.

Table B
Combined Program Element and COC Impacts (July 2020 – June 2023) and Comparison to Goals

TDM Program Element	Participation	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Program Elements (all collectively)					
2023 Goal		119,711	2,133,870	0.9130	0.5300
Impacts (7/20 – 6/23)		99,780	1,855,412	0.3866	0.3116
Net Credit or (Deficit)		**(19,931)**	**(278,458)**	**(0.5264)**	**(0.2184)**
Commuter Operations Center – Basic Services					
2023 Goal	91,609	24,425	512,637	0.2410	0.1150
Impacts (7/20 – 6/23)	51,018	19,048	297,963	0.0676	0.0611
Net Credit or (Deficit)	**(40,591)**	**(5,377)**	**(214,674)**	**(0.1734)**	**(0.0539)**
Commuter Operations Center – Software Upgrades [1]					
2023 Goal	4,681	2,379	66,442	0.0280	0.0110
Impacts (7/20 – 6/23)	3,596	669	15,454	0.0030	0.0022
Net Credit or (Deficit)	**(1,085)**	**(1,710)**	**(50,988)**	**(0.0250)**	**(0.0088)**
All Program Elements plus COC					
2023 Goal		146,515	2,712,949	1.1820	0.6560
Impacts (7/20 – 6/23)		119,497	2,168,829	0.4572	0.3749
Net Credit or (Deficit)		**(27,018)**	**(544,120)**	**(0.7248)**	**(0.2811)**

1) Impacts for Commuter Operations Center – Software Upgrades are in addition to the impacts for the Commuter Operations Center – Basic Services. This project was previously part of the Integrated Rideshare program element.

In the early months of the pandemic, workplace and commuting adjustments were anticipated to be temporary. However, as the pandemic continued into 2021 and, to a lesser but still notable extent, into 2022 and 2023, it has become clear that work and commuting patterns remain unsettled. Except for the April through June 2020 period, the FY 2018 – FY 2020 TDM analysis represented a pre-pandemic period. By contrast, even in early 2023, many employers had not fully returned to pre-pandemic worksite operations and those that required return-to-work often adopted a hybrid workplace/work from home approach that kept many workers teleworking at least a few days per week. Thus, pandemic-related disruptions should be assumed for nearly all the FY 2021 – FY 2023 evaluation period.

Impacts of most Commuter Connections program elements are based on actual use of the programs and where shortfalls occurred against the vehicle trip and VMT reduction goals, they appear related to lower than expected commuter participation rates. For example, the number of commuters registered for Guaranteed Ride Home was just 18% of the goal for the program. The 14,501 commuters influenced or assisted by Mass Marketing were only 63% of the participation goal. And participation for the Commuter Operations Center was 56% of the goal for this service.

Commuter Connections' program enrollment was certainly affected by greater use of telework/work from home. But participation also could have been lower among commuters who continued to commute. While traffic began to resume in early 2021, traffic volumes and congestion are still below the pre-pandemic levels. This might have influenced some commuters who previously chose transit to avoid

driving or to gain a time advantage through use of carpool lanes to shift to driving alone, reducing their need for Commute Connections' assistance with non-drive alone travel modes. The only program element that met individual goals for participation and travel impacts was Telework–Maryland Assistance. This program benefitted from the expanded use of telework as a pandemic emergency response and the interest of both employers and individual teleworkers in obtaining information that could be helpful in navigating new work from home requirements.

Additional details on the calculations for each evaluation element are described in individual program sections of this report. These sections also explore factors that affected the achievement of goals.

Table C presents annual emission reduction results for CO2 emissions (greenhouse gas emissions - GHG) for each program element and for the COC. COG/TPB did not establish specific CO2 targets but COG has been measuring the impacts for other pollutants, thus these results are provided. As shown, the TDM program elements collectively reduce more than 178,000 annual tons of CO2 (greenhouse gas emissions). When the Commuter Operations Center is included, the emissions impact rises to 209,000 annual tons of CO2 (greenhouse gas emissions).

Table C
Annual CO2 Emission Impacts (July 2020 – June 2023) for Individual Program Element

TDM Program Element	Annual Tons CO2 Reduced
Maryland Telework Assistance [1]	48,460.3
Guaranteed Ride Home	4,529.5
Employer Outreach – all employers [2]	119,083.0
Employer Outreach – new/expanded employers [2]	18,963.0
Employer Outreach for Bicycling	198.3
Mass Marketing	6,223.6
Program Elements (all collectively)	**178,296.4**
Commuter Operations Center – basic services (not including Software Upgrades)	29,235.5
Commuter Operations Center – Software Upgrades	1,468.8
All Program Elements plus COC	**209,000.7**

1) Maryland impacts represent the portion of regional telework attributable to TW program activities in Maryland. Additional telework impacts from COG activities are assigned to Employer Outreach and the Commuter Operations Center. Total telework credited for conformity is higher than reported for the program element.
2) Impacts for new/expanded employer programs and Employer Outreach for Bicycling are included in the Employer Outreach – all employers figures.

Finally, Table D compares daily reductions in vehicle trips, VMT, NOx, and VOC from the 2023 TDM program element analysis (July 2020 through June 2023) to results of the 2020 analysis (July 2017 through June 2020). The impacts for Maryland Telework were higher in 2023 than in 2020 and the 2023 impacts for the Commuter Operation Center slightly exceeded those from the 2020 analysis. All other program elements experienced impact declines between 2020 and 2023, due in large part to drops in participation related to the coronavirus pandemic.

Table D
Impacts for Individual Program Elements 7/20– 6/23 Compared with 7/17 – 6/20

TDM Program Element	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Maryland Telework Assistance				
July 2020 – June 2023	24,681	489,911	0.1072	0.0898
July 2017 – June 2020	13,636	308,001	0.0664	0.0522
Change [1)]	11,045	181,910	0.0408	0.0376
Guaranteed Ride Home				
July 2020 – June 2023	2,013	52,201	0.0088	0.0054
July 2017 – June 2020	5,200	147,371	0.0253	0.0154
Change [1)]	(3,187)	(95,170)	(0.0165)	(0.0100)
Employer Outreach – All services except Employer Outreach for Bicycling				
July 2020 – June 2023	69,093	1,245,657	0.2564	0.2045
July 2017 – June 2020	85,396	1,487,279	0.2987	0.2285
Change [1)]	(16,303)	(241,622)	(0.0423)	(0.0240)
Employer Outreach for Bicycling				
July 2020 – June 2023	405	1,823	0.0007	0.0011
July 2017 – June 2020	449	1,886	0.0008	0.0012
Change [1)]	(44)	(63)	(0.0001)	(0.0001)
Mass Marketing				
July 2020 – June 2023	3,588	65,820	0.0135	0.0108
July 2017 – June 2020	14,031	277,511	0.0554	0.0415
Change [1)]	(10,443)	(211,691)	(0.0419)	(0.0307)
All TDM Program Elements (Excluding Commuter Operations Center)				
July 2020 – June 2023	99,780	1,855,412	0.3866	0.3116
July 2017 – June 2020	119,249	2,231,875	0.4488	0.3407
Change [1)]	(19,469)	(376,463)	(0.0622)	(0.0291)
Commuter Operations Center (Basic Services + Software Upgrades)				
July 2020 – June 2023	19,717	313,417	0.0706	0.0633
July 2017 – June 2020	17,644	415,676	0.0802	0.0567
Change [1)]	2,073	(102,259)	(0.0096)	0.0066

1) Change in emissions is due in part to reduction in emission factors from 2020 to 2023.

Societal Benefits of FY 2021 – FY 2023 Travel and Emissions Impacts

Since its inception in 1997, the Commuter Connections TDM analysis has been undertaken primarily to document travel and emissions impacts of each program element and compare the impacts against the goals set for the elements. This remains a central focus of the analysis for the FY 2021 – FY 2023 analysis. But the program elements likely do offer other benefits to residents and commuters of the Washington, DC metropolitan region, in societal objectives such as greenhouse gas emissions reductions, greater mobility, improved road safety, and enhanced transportation system performance.

These benefits have joined congestion and air quality as forces shaping the region's transportation policies, making them also relevant to Commuter Connections partners and funders. Documenting the types and magnitude of these benefits demonstrates the broad value of Commuter Connections programs to the community and the value of investments made in the programs. Documenting these contributions also supports the regional response to the federally-mandated performance-based planning and programming (PBPP) process required of states and MPOs. Under this requirement, MWCOG must track a variety of performance indicators related to transportation system performance, such as hours of peak hour excessive roadway delay.

The FY 2021 – FY 2023 TDM analysis includes an analysis component, which was first added to the FY 2015 – FY 2017 analysis, to estimate regional cost savings generated for selected societal benefits of the travel and emissions impacts generated by the TDM program elements. These benefits include:

- Air pollution/emissions reductions in NOx and VOC
- Reduction in greenhouse gas emissions/CO2
- Reduction in congestion (reduced hours of peak period travel delay)
- Reduction in fuel consumption (gasoline cost saving)
- Improved road safety (crashes reduced per 1 million VMT)
- Noise pollution reduction (reduced motor vehicle noise)

The societal cost savings for each of these benefits was calculated by defining a unit of benefit associated with each type of benefit (e.g., tons of CO2 reduced and hours of delay reduced for reduction in congestion) and multiplying the benefit units by a unit cost factor (e.g., cost per ton of pollutant or cost per hour of delay). The conversion to benefit units and the unit cost factors for most benefits were obtained from the Trip Reduction Impacts of Mobility Management Strategies (TRIMMS™) model developed by the Center for Urban Transportation Research. TRIMMS™ estimates societal cost saving benefits of TDM actions for the societal benefits shown above. Appendix 11 defines the methodology used for each benefit and the specific sources used to derive unit benefits and unit costs.

Table E presents the cost saving associated with each type of benefit and the overall societal cost saving calculated for the TDM program elements and the Commuter Operations Center combined. As shown, the combination of the TDM program elements and Commuter Operations Center generate about $519,807 of daily cost saving across the societal benefits included in the calculation. The largest share of the cost saving is in reduction of excess fuel used; this benefit is valued at over $317,846 per day, or about 61% of the total daily benefits. Reduction in hours of travel delay accounts for about 17% of the total daily benefit ($87,730). Noise pollution reduction generates about 9% and the air pollution/ greenhouse gas reduction combined benefits and road safety crash reduction benefits are responsible for about 6% and 7%, respectively, of the total cost saving.

Table E
Daily Societal Benefit Cost Savings Generated by
FY 2021 – FY 2023 TDM Program Elements and Commuter Operations Center Impacts

Table 11-3 – Societal Benefit Cost Savings Generated by TDM Program Elements (FY 2021 – FY 2023)

Societal Benefit	Benefit Unit	Benefit Base Units	Cost per Unit of Benefit	Total Daily Cost Saving
Air pollution				
- NOx	Tons NOx removed	0.457 T	$1,612	$737
- VOC	Tons VOC removed	0.375 T	$133	$50
Greenhouse gases	Tons CO2 removed	836.0 T	$36	$30,096
Noise pollution	Total VMT reduced	2,168,829 VMT	$0.0223	$48,365
Congestion	Hours of delay reduced	2,883 hours	$30.43	$87,730
Excess fuel used	Gallons of fuel saved	93,484 gal	$3.40	$317,846
Health/safety [1)]	Crashes avoided/1 M VMT	2.193 crashes	$15,952	$34,983
All benefits				**$519,807**

1) Health and safety benefit base units and cost per unit are weighted averages of crash occurrences by severity.

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Section 1 Introduction

This report presents the results of an evaluation of four voluntary Transportation Demand Management (TDM) program elements implemented by the National Capital Region Transportation Planning Board's (TPB) Commuter Connections program at the Metropolitan Washington Council of Governments (COG). The objective of these elements is to improve the travel experience of regional commuters and support regional efforts to meet air quality goals and mitigate growth in vehicle miles traveled and growth in use of single occupant vehicles. This evaluation documents transportation and air quality impacts for the three-year evaluation period between July 1, 2021 and June 30, 2023 (FY 2021 – FY 2023), for the following TDM program elements:

- **Maryland Telework Assistance** – This TDM program element provides information and assistance to Maryland commuters and employers to further in-home and co-working/telecenter-based teleworking.
- **Guaranteed Ride Home** – Eliminates a barrier to use of alternative modes by providing free rides home in the event of an unexpected personal emergency or unscheduled overtime for commuters who use transit, vanpool, carpool, or bicycles to get to or from work.
- **Employer Outreach** – Provides regional outreach services to encourage large, private-sector and non-profit employers to voluntarily implement commuter assistance strategies that will contribute to reducing vehicle trips to worksites. Includes the efforts of jurisdiction sales representatives to foster new and expanded trip reduction programs. The Employer Outreach for Bicycling component also is part of this analysis.

- **Mass Marketing** – Involves a large-scale, comprehensive media campaign to inform the region's commuters of services available from Commuter Connections as one way to address commuters' frustration about the commute. Various incentive programs and special promotional events also are part of this TDM program element.

COG/TPB's Commuter Connections program, which operates an ongoing regional commute assistance program, is responsible for implementing these TDM program elements. COG is the central administrator of these elements, working with partner organizations, such as local jurisdiction commute programs and transportation management associations (TMAs) to implement them.

COG also operates the Commuter Operations Center (COC), providing direct commute assistance services, such as carpool and vanpool matching, transit, telework, and Park & Ride information, and other information on travel services that are most cost-effectively provided by a central agency, through telephone and internet assistance to commuters. Other services are offered by local organizations and coordinated regionally by the Commuter Connections Subcommittee, a coordinating body comprised of state and local government agencies in the region, several large federal employers, several public-private Transportation Management Associations (TMAs), and other partner organizations.

When the TDM program elements were first implemented, Commuter Connections and COG/TPB staff elected to undertake significant evaluation for each element. The purpose of the evaluation was to

develop timely and meaningful information for regional transportation and air quality decision-makers, COG staff, COG program funders, and state and local commute assistance program managers to guide sound decision-making about the program elements.

This report summarizes the results of the evaluation activities undertaken by Commuter Connections during the evaluation period and presents the transportation and air quality impacts of the individual program elements. The report also documents impacts of the commuter assistance activities of the Commuter Operations Center, which COG operates to provide a basic level of commuter information and ridesharing assistance services throughout the Washington, DC metropolitan region. Results from this report will be used to support the region's transportation and environmental planning activities and the congestion management process.

This report represents a comprehensive evaluation for the four program elements and the COC. It should be noted, however, that the results are conservative in the sense that credit is included only for impacts that can be reasonably documented with accepted measurement methods and tools. Many of the calculations use data from surveys, which are subject to some statistical error, at rates typical of such surveys.

Additionally, the TDM program elements included in the analysis do not encompass all the TDM activities currently ongoing in the Washington metropolitan region. Many other organizations, such as states and local jurisdictions; transportation management associations; transit agencies, vanpool vendors, and other transportation service providers; employers, commercial and residential building operators, and other public and private organizations also offer services that perform similar functions to the TDM program elements implemented through the Commuter Connections program. The impacts of these other TDM services are not addressed in this framework, but certainly are assumed to provide travel and air quality benefits to the region and personal benefits to the commuters who use them.

In June 1997, a consultant team was retained to assist COG to define an evaluation methodology. This methodology was used for the first triennial evaluation in 1999. In 2001, 2004, 2007, 2010, 2013, 2016, 2019, and 2022, the consultants, along with COG, expanded and enhanced the methodologies, data collection tools, and data sources to expand the coverage, corroborate assumptions, and enhance the reliability of the evaluation estimates. Section 3 presents highlights of the changes made to update the framework methodology. Readers who desire additional details on the methodology are directed to the report entitled, "Commuter Connections' Transportation Demand Management Evaluation Project: Transportation Demand Management (TDM) Program Elements Revised Evaluation Framework, FY 2021 – FY 2023." This document (*TDM Evaluation Framework, 2021-2023*) is available on-line at www.commuterconnections.org.

The data collection activities recommended in the Evaluation Framework report were undertaken by COG/TPB staff or by data collection consultants retained by COG. This report summarizes the results of the evaluation activities and analysis. The report also summarizes the transportation and air quality impacts of commuter assistance activities of the Commuter Operations Center. The COC is not an adopted TDM program element but is included in this analysis because its operation supports most of the regional Commuter Connections program elements.

Organization of the Report

This TDM Analysis Report is divided into eight sections following this Introduction section:

- Section 2 Overall Summary of TDM Analysis Results
- Section 3 Highlights of Revised Evaluation Methodology
- Section 4 Maryland Telework Assistance
- Section 5 Guaranteed Ride Home
- Section 6 Employer Outreach
- Section 7 Mass Marketing
- Section 8 Commuter Operations Center
- Section 9 Summary of TDM Program Element Impacts

Section 2 summarizes the overall results for each TDM program element individually and for all program elements plus the Commuter Operations Center collectively. Section 3 presents highlights of the revised evaluation methodology developed in 2022 for the FY 2021 – FY 2023 evaluation period. Sections 4 through 7 present for each individual program element, a brief description of the element and its purpose, an overview of the methodology used to estimate the element's impacts and the data used in the analysis, and a comparison of the measured impacts against the goals set for the element. Section 8 presents similar information for the Commuter Operations Center. The final section, Section 9, presents general conclusions from the analysis.

Summaries of the calculations of transportation and air quality impacts of individual program elements also are included in appendices following the body of the report.

Section 2 Summary of TDM Analysis Results

The objective of the evaluation is to estimate reductions in vehicle trips (VT), vehicle miles traveled (VMT), and tons of vehicle pollutants resulting from implementation of each program element between July 2020 and June 2023 and to compare these impacts against the goals established for the TDM program elements. The Revised Evaluation Framework document finalized in March 2022 also recommended that other performance measures be tracked for these TDM program elements to assess levels of program participation, utilization, satisfaction, and cost-effectiveness. These measures are tracked by Commuter Connections on a monthly and annual basis for the program elements and are reported in other documents.

Travel and Emissions Impacts Overall and By Program Element

Tables 1 and 2 present impact results for reductions in the following impacts and comparisons to the goals set for the impact measures:

- Vehicle trips (VT)
- Vehicle miles traveled (VMT)
- Nitrogen Oxides (NOx)
- Volatile Organic Compounds (VOC)

As shown in Table 1, the four program elements fell about 17% short of the collective goal for vehicle trips reduced and 13% short of the goal for VMT reduced. The program elements did not reach the emission goals; the impact for NOx was 58% under the goal and VOC impact was 41% under the goal, but these deficits were due in part to reductions in the emission factors. The program goals were set in 2006, using 2006 emission factors. Goals for some program elements were re-set after the 2014 and 2017 TDM analyses were conducted but the emission factors used in the 2023 evaluation were considerably lower than the factors from past evaluations, reflecting a cleaner vehicle fleet.

When the COC results are added to the impacts of the four program elements impacts (Table 2), the combined impact was 18% below the vehicle trips reduction goal and 20% under the goal for VMT reduced. The combined program element–COC program impact fell 61% short of the NOx goal and was 43% below the VOC goal. Again, the change in the emission factors affected the emission results.

Many factors enter the calculation of impacts, including participation in individual program elements as well as the current and previous commute patterns of program users. Explanations for individual program element results are presented in later sections of the report. But without question, commute disruptions related to the coronavirus pandemic were a significant factor in the overall impact results.

As the coronavirus pandemic began, in spring 2020, stay-at-home directives were implemented throughout the Washington metropolitan region, closing many worksites and disrupting typical commutes. Many employees shifted to working from home all or most of their workdays. Additionally, some employees became unemployed or changed jobs, and some who continued commuting to an outside work location changed their commute mode to minimize contact with other commuters.

Table 1
Daily Impacts for Individual Program Elements (July 2020 – June 2023) and Comparison to Goals

TDM Program Element	Participation [1]	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
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2023 Goal	31,854	11,830	241,209	0.1220	0.0720
Impacts (7/20 – 6/23)	58,961	24,681	489,911	0.1072	0.0898
Net Credit or (Deficit)	**27,107**	**12,851**	**248,702**	**(0.0148)**	**0.0178**
Guaranteed Ride Home					
2023 Goal	18,496	6,296	177,568	0.0890	0.0480
Impacts (7/20 – 6/23)	3,308	2,013	52,201	0.0088	0.0054
Net Credit or (Deficit)	**(15,188)**	**(4,283)**	**(125,367)**	**(0.0802)**	**(0.0426)**
Employer Outreach – all employers participating [3]					
2023 Goal	2,031	90,776	1,533,161	0.6170	0.3850
Impacts (7/20 – 6/23)	2,166	69,498	1,247,480	0.2571	0.2056
Net Credit or (Deficit)	**135**	**(21,278)**	**(285,681)**	**(0.3599)**	**(0.1794)**
Employer Outreach – new / expanded employer services since July 2020 [3]					
2023 Goal	N/A	N/A	N/A	N/A	N/A
Impacts (7/20 – 6/23)	1,177	10,946	198,638	0.0408	0.0325
Net Credit or (Deficit)	N/A	N/A	N/A	N/A	N/A
Employer Outreach for Bicycling [3]					
2023 Goal	590	404	2,421	0.0016	0.0015
Impacts (7/20 – 6/23)	732	405	1,823	0.0007	0.0011
Net Credit or (Deficit)	**142**	**1**	**(598)**	**(0.0009)**	**(0.0004)**
Mass Marketing					
2023 Goal	23,168	10,809	181,932	0.0850	0.0250
Impacts (7/20 – 6/23)	14,501	3,588	65,820	0.0135	0.0108
Net Credit or (Deficit)	**(8,667)**	**(7,221)**	**(116,112)**	**(0.0715)**	**(0.0142)**
TDM Program Elements (all collectively)					
2023 Goal		119,711	2,133,870	0.9130	0.5300
Impacts (7/20 – 6/23)		99,780	1,855,412	0.3866	0.3116
Net Credit or (Deficit)		**(19,931)**	**(278,458)**	**(0.5264)**	**(0.2184)**

1) Participation refers to number of commuters participating, except for the Employer Outreach program element. For this element, participation equals the number of employers participating.

2) Maryland impacts represent portion of regional telework attributable to TW program activities in Maryland. Total telework credited for conformity is higher than reported for the program element.

3) Impacts for Employer Outreach - all employers participating includes impacts for Employer Outreach – new / expanded employer services since July 2020 and for Employer Outreach for Bicycling.

Table 2
Combined Program Element and COC Impacts (July 2020 – June 2023) and Comparison to Goals

TDM Program Element	Participation	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Program Elements (all collectively)					
2023 Goal		119,711	2,133,870	0.9130	0.5300
Impacts (7/20 – 6/23)		99,780	1,855,412	0.3866	0.3116
Net Credit or (Deficit)		**(19,931)**	**(278,458)**	**(0.5264)**	**(0.2184)**
Commuter Operations Center – Basic Services					
2023 Goal	91,609	24,425	512,637	0.2410	0.1150
Impacts (7/20 – 6/23)	51,018	19,048	297,963	0.0676	0.0611
Net Credit or (Deficit)	**(40,591)**	**(5,377)**	**(214,674)**	**(0.1734)**	**(0.0539)**
Commuter Operations Center – Software Upgrades [1]					
2023 Goal	4,681	2,379	66,442	0.0280	0.0110
Impacts (7/20 – 6/23)	3,596	669	15,454	0.0030	0.0022
Net Credit or (Deficit)	**(1,085)**	**(1,710)**	**(50,988)**	**(0.0250)**	**(0.0088)**
All Program Elements plus COC					
2023 Goal		146,515	2,712,949	1.1820	0.6560
Impacts (7/20 – 6/23)		119,497	2,168,829	0.4572	0.3749
Net Credit or (Deficit)		**(27,018)**	**(544,120)**	**(0.7248)**	**(0.2811)**

1) Impacts for Commuter Operations Center – Software Upgrades are in addition to the impacts for the Commuter Operations Center – Basic Services. This project was previously part of the Integrated Rideshare program element.

In the early months of the pandemic, workplace and commuting adjustments were anticipated to be temporary. However, as the pandemic continued into 2021 and, to a lesser but still notable extent, into 2022, it has become clear that work and commuting patterns remain unsettled. Except for the April through June 2020 period, the 2020 TDM analysis represented a pre-pandemic period. While travel has been resuming since late 2021, many employers had not fully returned to pre-pandemic worksite operations even at the end of 2022, thus pandemic-related disruptions should be expected for nearly all the FY 2021 – FY 2023 evaluation period.

Impacts of most Commuter Connections program elements are based on actual use of the programs and where shortfalls occurred against the vehicle trip and VMT reduction goals, they appear related to lower than expected commuter participation rates. For example, the number of commuters registered for Guaranteed Ride Home was just 18% of the goal for the program. The 14,501 commuters influenced or assisted by Mass Marketing were only 63% of the participation goal. And participation for the Commuter Operations Center was 56% of the goal for this service.

The only program element that met individual goals for participation and travel impacts was Telework–Maryland Assistance. This program benefitted from the expanded use of telework as a pandemic emergency response and the interest of both employers and individual teleworkers in obtaining information that could be helpful in navigating new work from home requirements.

Additional details on the calculations for each evaluation element are described in individual program sections of this report. These sections also explore factors that affected the achievement of goals.

Table 3 presents annual emission reduction results for CO2 emissions (greenhouse gas emissions - GHG) for each program element and for the COC. COG/TPB did not establish specific CO2 targets but COG has been measuring the impacts for other pollutants, thus these results are provided. As shown, the TDM program elements collectively reduce more than 178,000 annual tons of CO2 (greenhouse gas emissions). When the Commuter Operations Center is included, the emissions impact rises to 209,000 annual tons of CO2 (greenhouse gas emissions).

Table 3
Annual CO2 Emission Impacts (July 2020 – June 2023) for Individual Program Element

TDM Program Element	Annual Tons CO2 Reduced
Maryland Telework Assistance [1]	48,460.3
Guaranteed Ride Home	4,529.5
Employer Outreach – all employers [2]	119,083.0
Employer Outreach – new/expanded employers [2]	18,963.0
Employer Outreach for Bicycling	198.3
Mass Marketing	6,223.6
Program Elements (all collectively)	**178,296.4**
Commuter Operations Center – basic services (not including Software Upgrades)	29,235.5
Commuter Operations Center – Software Upgrades	1,468.8
All Program Elements plus COC	**209,000.7**

1) Maryland impacts represent the portion of regional telework attributable to TW program activities in Maryland. Additional telework impacts from COG activities are assigned to Employer Outreach and the Commuter Operations Center. Total telework credited for conformity is higher than reported for the program element.

2) Impacts for new/expanded employer programs and Employer Outreach for Bicycling are included in the Employer Outreach – all employers figures.

Finally, Table 4 compares daily reductions in vehicle trips, VMT, NOx, and VOC from the 2023 TDM program element analysis (July 2020 through June 2023) to results of the 2020 analysis (July 2017 through June 2020). The impacts for Maryland Telework were higher in 2023 than in 2020 and the 2023 impacts for the Commuter Operation Center slightly exceeded those from the 2020 analysis. All other program elements experienced impact declines between 2020 and 2023, due in large part to drops in participation related to the coronavirus pandemic.

Table 4
Impacts for Individual Program Elements 7/20– 6/23 Compared with 7/17 – 6/20

TDM Program Element	Daily Vehicle Trips Reduced	Daily VMT Reduced	Daily Tons NOx Reduced	Daily Tons VOC Reduced
Maryland Telework Assistance				
July 2020 – June 2023	24,681	489,911	0.1072	0.0898
July 2017 – June 2020	13,636	308,001	0.0664	0.0522
Change [1)]	11,045	181,910	0.0408	0.0376
Guaranteed Ride Home				
July 2020 – June 2023	2,013	52,201	0.0088	0.0054
July 2017 – June 2020	5,200	147,371	0.0253	0.0154
Change [1)]	(3,187)	(95,170)	(0.0165)	(0.0100)
Employer Outreach – All services except Employer Outreach for Bicycling				
July 2020 – June 2023	69,093	1,245,657	0.2564	0.2045
July 2017 – June 2020	85,396	1,487,279	0.2987	0.2285
Change [1)]	(16,303)	(241,622)	(0.0423)	(0.0240)
Employer Outreach for Bicycling				
July 2020 – June 2023	405	1,823	0.0007	0.0011
July 2017 – June 2020	449	1,886	0.0008	0.0012
Change [1)]	(44)	(63)	(0.0001)	(0.0001)
Mass Marketing				
July 2020 – June 2023	3,588	65,820	0.0135	0.0108
July 2017 – June 2020	14,031	277,511	0.0554	0.0415
Change [1)]	(10,443)	(211,691)	(0.0419)	(0.0307)
All TDM Program Elements (Excluding Commuter Operations Center)				
July 2020 – June 2023	99,780	1,855,412	0.3866	0.3116
July 2017 – June 2020	119,249	2,231,875	0.4488	0.3407
Change [1)]	(19,469)	(376,463)	(0.0622)	(0.0291)
Commuter Operations Center (Basic Services + Software Upgrades)				
July 2020 – June 2023	19,717	313,417	0.0706	0.0633
July 2017 – June 2020	17,644	415,676	0.0802	0.0567
Change [1)]	2,073	(102,259)	(0.0096)	0.0066

1) Change in emissions is due in part to reduction in emission factors from 2020 to 2023.

Societal Benefits of FY 2021 – FY 2023 Travel and Emissions Impacts

Since its inception in 1997, the Commuter Connections TDM analysis has been undertaken primarily to document travel and emissions impacts of each program element and compare the impacts against the goals set for the elements. This remains a central focus of the analysis for the FY 2021 – FY 2023 analysis. But the program elements likely do offer other benefit to residents and commuters of the

Washington region, in societal objectives such as greenhouse gas emissions reductions, greater mobility, improved road safety, and enhanced transportation system performance.

These benefits have joined congestion and air quality as forces shaping the region's transportation policies, making them also relevant to Commuter Connections partners and funders. Documenting the types and magnitude of these benefits demonstrates the broad value of Commuter Connections programs to the community and the value of investments made in the programs. Documenting these contributions also supports the regional response to the federally-mandated performance-based planning and programming (PBPP) process required of states and MPOs. Under this requirement, MWCOG must track a variety of performance indicators related to transportation system performance, such as hours of peak hour excessive roadway delay.

The FY 2021 – FY 2023 TDM analysis includes an analysis component, which was first added to the FY 2015 – FY 2017 analysis, to estimate regional cost savings generated for selected societal benefits of the travel and emissions impacts generated by the TDM program elements. These benefits include:

- Air pollution/emissions reductions in NOx and VOC
- Reduction in greenhouse gas emissions/CO2
- Reduction in congestion (reduced hours of peak period travel delay)
- Reduction in fuel consumption (gasoline cost saving)
- Improved road safety (crashes reduced per 1 million VMT)
- Noise pollution reduction (reduced motor vehicle noise)

The societal cost savings for each of these benefits was calculated by defining a unit of benefit associated with each type of benefit (e.g., tons of CO2 reduced and hours of delay reduced for reduction in congestion) and multiplying the benefit units by a unit cost factor (e.g., cost per ton of pollutant or cost per hour of delay). The conversion to benefit units and the unit cost factors for most benefits were obtained from the Trip Reduction Impacts of Mobility Management Strategies (TRIMMS™) model developed by the Center for Urban Transportation Research. TRIMMS™ estimates societal cost saving benefits of TDM actions for the societal benefits shown above. Appendix 11 defines the methodology used for each benefit and the specific sources used to derive unit benefits and unit costs.

Table 5 presents the cost saving associated with each type of benefit and the overall societal cost saving calculated for the TDM program elements and the Commuter Operations Center combined. As shown, the combination of the TDM program elements and Commuter Operations Center generate about $519,807 of daily cost saving across the societal benefits included in the calculation. The largest share of the cost saving is in reduction of excess fuel used; this benefit is valued at over $317,846 per day, or about 61% of the total daily benefits. Reduction in hours of travel delay accounts for about 17% of the total daily benefit ($87,730). Noise pollution reduction generates about 9% and the air pollution/ greenhouse gas reduction combined benefits and road safety crash reduction benefits are responsible for about 6% and 7%, respectively, of the total cost saving.

Table 5
Daily Societal Benefit Cost Savings Generated by
FY 2021 – FY 2023 TDM Program Elements and Commuter Operations Center Impacts

Societal Benefit	Benefit Unit	Benefit Base Units	Cost per Unit of Benefit	Total Daily Cost Saving
Air pollution				
- NOx	Tons NOx removed	0.457 T	$1,612	$737
- VOC	Tons VOC removed	0.375 T	$133	$50
Greenhouse gases	Tons CO2 removed	836.0 T	$36	$30,096
Noise pollution	Total VMT reduced	2,168,829 VMT	$0.0223	$48,365
Congestion	Hours of delay reduced	2,883 hours	$30.43	$87,730
Excess fuel used	Gallons of fuel saved	93,484 gal	$3.40	$317,846
Health/safety [1)]	Crashes avoided/1 M VMT	2.193 crashes	$15,952	$34,983
All benefits				**$519,807**

1) Health and safety benefit base units and cost per unit are weighted averages of crash occurrences by severity.

Section 3 Highlights of Revised Evaluation Methodology

Background

In 1997, consultants selected by COG developed an evaluation framework to guide the collection and analysis of data to estimate travel and air quality impacts of Commuter Connections TDM program elements. This methodology described evaluation objectives, performance measures for each program element, data needs and data collection tools and sources, and analysis and calculation steps to estimate travel, air quality, energy, and consumer cost impacts of the elements. The framework also presented recommendations for an evaluation schedule, responsibilities, and reporting of results to maintain and utilize evaluation information.

The methodology was designed to collect sufficient data, using recognized and accepted survey and tracking techniques, to allow COG to measure TDM program elements' performance with confidence but also in an efficient manner. The first program element analysis, conducted in 1999, reinforced the view that data collection and evaluation for TDM programs can be challenging, especially when the programs are voluntary. Reliable data can be difficult to assemble, calculation assumptions may need to use proxy data, and factors outside the program can influence results.

Since that first evaluation, the data collection and analysis methodologies evolved to enhance the accuracy, rigor, coverage, and reliability of the evaluations. A revised methodology was prepared in 2001, reflecting these recommendations. The methodology has been updated triennially, in 2001, 2004, 2007, 2010, 2013, 2016, 2019, and 2022, following triennial evaluations, to enhance the analysis results.

This section identifies key enhancements that were made to the methodology since the 2020 TDM Analysis Report was completed and discusses the overall rigor of the evaluation framework as compared to other regions. Overall, the TDM evaluation process employed for this analysis is among the most rigorous and comprehensive in the United States.

Evaluation Methodology Overview

Evaluation Principles

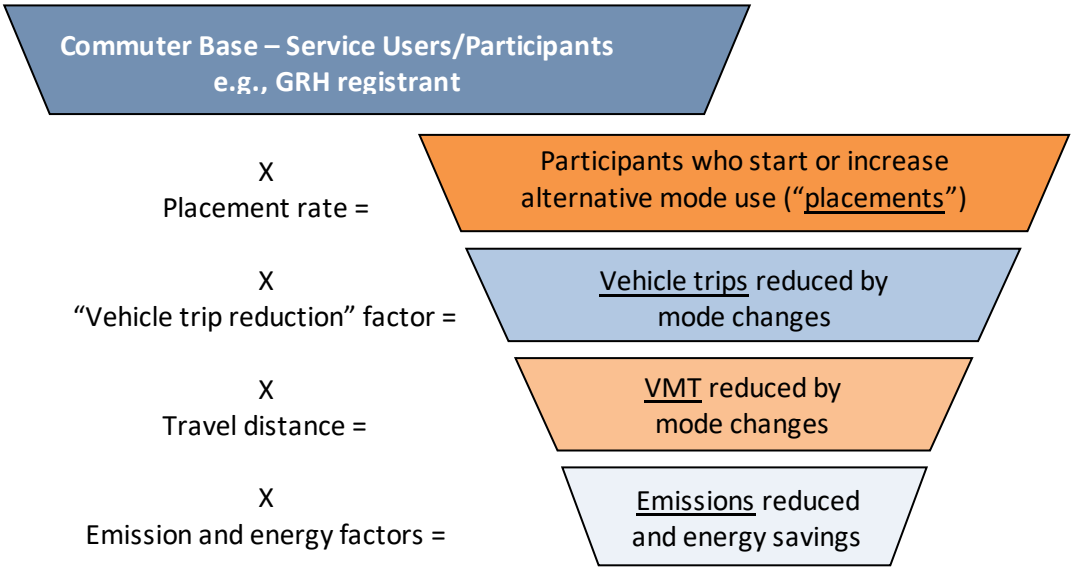
The TDM evaluation process was established on several key evaluation principles that formed the foundation for the Evaluation Framework and that have guided the process since 1997. Some of those principles, which have since been adopted by other regions evaluating TDM programs, include:

- Provide sound, definitive, and useful information about the results of the program
- Assure objective evaluation by using a third-party (other than a funding or implementing agent)
- Avoid double counting by separating out the impacts of individual program elements
- Report only those impacts associated with the program element, and not impacts of commuter services that were in place prior to the adoption of the program elements being evaluated
- Follow accepted and recognized evaluation techniques
- Be rigorous, ongoing, resource efficient, unobtrusive for COG partners, and compatible with regional, state, and national practices

Evaluation Methodology Steps

The calculation of Commuter Connections' program impacts is based on a step-by-step methodology that estimates transportation and air quality benefits generated by the program elements. The methodology calls for a series of "multiplier factors," derived primarily from survey data, to be applied to a known number of commuters who might be influenced or assisted by a program element to make a travel pattern change (population base). The result of these step-by-step calculations is an estimate of the numbers of vehicle trips, VMT, and emissions reduced through commute changes made by commuters after contact with the program element (Figure 1).

Figure 1: Impact Calculation Multiplier Steps



For most program elements, the population base is commuters who participate in or use the program service, although in a few cases, the population is all regional commuters. The methodology requires an accurate documentation of the participation in each element and an accurate count of other population bases. This is accomplished primarily by program participant tracking performed by Commuter Connections staff and survey results.

The methodology then applies five primary calculation factors, derived from surveys of the populations of interest, to the population base. Each program element will have a unique set of factors, depending on the characteristics of the service and users, but the basic calculation method is the same for all services. Tailored surveys have been developed for each of these services to produce unique placement rates and VTR factors for each element. The calculation factors and the calculation steps are briefly described below.

1. Estimate "placement rate" and "influenced placement rate"
   Placement rate refers to the percentage of the population base "placed" in an alternative mode after receiving a service. Placement rates are typically estimated from survey data of a sample of the

population and vary by service, depending on the characteristics of the service and population. To collect placement rate data, service users are asked several questions:

- What modes do you use to commute now and how many days per week do you use them?
- Did you make any changes in your commute since you received "X" service?
- How did you commute before you received this service?
- Did the service encourage or assist you to make this change?

Users who made a travel change are considered "placements." For most services, two rates were estimated, distinguished by the duration of new mode use. The *Continued* rate represents users who shifted to a new alternative mode and continued using the new mode. For example, a 20% Continued placement rate means 20% of service users started using a new alternative mode and were still using that mode when a user survey was conducted. The *Temporary* rate represents users who tried a new alternative mode but returned to their original mode within the evaluation period. Temporary changes are credited only for the duration of time the new mode was used.

TDM Program Element Evaluation
Basic Program Impact Calculation Methodology Steps

Estimate Commuter Population Base	= e.g., all commuters, GRH applicants, CC online system users, EO employees
Impact Calculation Steps	
1. Derive placement rate (from user survey data)	= Proportion of commuters who made a travel change using the element
2. Estimate number of "placements"	= Population base x placement rate
3. Derive VTR factor (from user survey data)	= Average daily vehicle trips reduced per placement
4. Estimate vehicle trips (VT) reduced	
- GRH, COC, Telework, MM	= placements x VTR factor
- Employer Outreach	= Modeled method
5. Estimate VMT reduced	= Vehicle trips reduced x average trip length
6. Adjust VT and VMT for SOV access	
- Adjusted vehicle trips reduced	= Total vehicle trips – SOV access trips
- Adjusted VMT reduced	= Total VMT – SOV access VMT
7. Estimate emissions reduced	= Vehicle trips x "trip end" emission factors = VMT x "running" emission factor
9. Estimate energy and commuter savings	= VMT reduced x average fuel consumption = VMT reduced x average vehicle operating cost

2. Estimate the number of new alternative mode placements
   Step 2 estimates the number of program element users who were influenced to start or increase use of alternative modes. It was calculated as:

   Total Population base x Placement rate (from Step 1)

3. Estimate the vehicle trip reduction factor for new placements
   Next, the vehicle trip reduction (VTR) factor is estimated for each element. The VTR factor is equal to the average daily vehicle trips reduced per placement, accounting for three types of changes:

   1) Shifts to an alternative mode, either from driving alone or from another alternative mode
   2) Increased use of alternative modes
   3) Increase in the number of riders in an existing carpool or vanpool

   The VTR factor combines the trip reduction results of all placements into an average reduction per placement. Note that shifts from alternative modes to drive alone were not included in the VTR factor, since these changes are typically not caused or motivated by the program element.

4. Estimate vehicle trips reduced
   The number of daily vehicle trips reduced for the program element was estimated by multiplying the number of alternative mode placements by the element's VTR factor:

   Total placements (from Step 2) x VTR factor (from Step 3)

5. Estimate vehicle miles traveled (VMT) reduced
   The daily VMT reduced was calculated by multiplying the number of daily vehicle trips reduced by the average travel distance for program element users who made a travel change.

   Total vehicle trips reduced (from Step 4) x one-way travel distance

6. Adjust vehicle trips and VMT for access mode
   This step adjusts the vehicle trip and VMT reductions to account for commuters who drive alone to where they meet a rideshare partner or board a bus or train. This step eliminates "cold starts" from the emission analysis. The "adjusted" vehicle trips reduced and VMT reduced, rather than the initial totals, were used to calculate emissions reduced.

7. Estimate emissions reduced
   Daily emissions reduced by mode shifts were estimated by multiplying regional emission factors by the number of vehicle trips and VMT reduced. The emissions factors were obtained from Commuter Connections for FY 2023 and were consistent with the regional planning process. The emissions factors account for emissions created from a "cold start," when a vehicle is first started, a "hot soak," that occur when the vehicle is later turned off, and the emissions generated per mile of travel by a warmed-up vehicle. Daily emissions reductions were calculated for NOx and VOC. Annual emissions reductions were calculated for CO2.

   Adjusted vehicle trips reduced (from Step 6) x Trip emission factor
   Adjusted VMT reduced (from Step 6) x VMT (running) emission factor

8. Estimate the energy savings
   Energy savings is reported as gallons of gasoline saved and was estimated by multiplying the VMT reduced by an average fuel consumption factor for the regional mix of light duty vehicles.

These steps were established in the evaluation framework developed in 1997 and remained largely unchanged for the subsequent evaluations. They also will be applied to the FY 2021 – FY 2023 evaluation described in this report.

Key Evaluation Issues

Several other issues are noted below, related to the high level of rigor built into the evaluation process:

- Avoid Double Counting – The evaluation separates the impacts of individual Commuter Connections TDM program elements and applies discount factors to avoid overestimating benefits when a commuter uses more than one of the program element services. For example, carpools might be formed as a joint result of online ridematching and GRH. These impacts must either be credited to one of the two program elements or divided between the elements in proportion to their respective influences in encouraging the change. Program benefits are not necessarily additive.
- Separate Impacts of Program Elements – Similarly, the evaluation separates the impacts of Commuter Operations Center "basic" services from the impacts of the other TDM program elements. This is especially relevant for the Mass Marketing program element, because its impacts can be "direct," meaning the marketing alone motivated an alternative mode shift, or "referred," meaning the marketing influenced commuters to utilize another Commuter Connections program, such as GRH or ridematching. In such cases, the travel and air quality impacts will be assigned to the element or to the Commuter Operations Center, based on their respective influences.
- Account for Commute Mode Prior to Change – Prior mode is an important variable in this evaluation, because a shift to an alternative mode does not always mean a vehicle trip was eliminated. Vehicle trips are reduced only in three cases: 1) the commuter shifts from driving alone to an alternative mode, 2) the commuter increases the frequency of use of an alternative mode, or 3) the commuter shifts to a higher-occupancy mode (e.g., from carpool to vanpool or vanpool to transit). Appendix 1 illustrates the calculation of the vehicle trip reduction (VTR) factor used to convert the number of alternative modes placements into the number of vehicle trips reduced, considering various types of before-after alternative mode combinations.
- Account for Access Mode to Transit and Carpool/Vanpool – For emission reduction evaluation purposes, the evaluation also accounts for the access mode of carpoolers, vanpoolers, and transit riders, that is, how commuters who use these modes travel from home to Park & Ride lots, bus stops, train stations, or other places where they meet rideshare partners or board a bus or train. Access mode is a minor issue in the evaluation of VMT reduction, because access trips generally account for a small portion of the total miles between home and work and the alternative mode generally is used for the most congested and longest portion of the trip. However, commuters who drive alone to the meeting point still make a vehicle trip and accumulate some drive-alone miles, which must be subtracted from the vehicle trips reduced and VMT reduced in the emissions analysis.
- Apply Life-cycle Assessment to Mode Shifts to Capture the Full Benefits for TDM Impacts – In Commuter Connections evaluations prior to 2017, mode shifts motivated by TDM program elements during an evaluation period were not carried over to the next evaluation cycle. But numerous surveys conducted for past TDM program analyses suggested that commuters who made mode shifts continued using the new modes for more than three years, so some additional impacts could be retained from one 3-year evaluation cycle to the next. To address this opportunity, in 2016, Commuter Connections conducted a new "Retention Rate" survey to estimate the share of past service users who continued to use alternative modes during the current cycle.

The survey interviewed Commuter Connections online system users and GRH users who last participated in these programs prior to the start of the 2020 evaluation period. Users were asked about their current modes, how long they had used the modes, and what Commuter Connections services they received. Commuters who were still using alternative modes were asked if Commuter Connections services influenced them to continue to use alternative modes. These survey data were used to develop "retained" placement rates and other factors for the GRH TDM program element and for the Commuter Operations Center and the 2017 and 2020 TDM analyses calculated "retained" impact credits, in addition to new impacts, for each of these program elements.

Commuter Connections conducted a second Retention Rate survey in February 2021, following the same method as for the 2017 survey. Results from this survey were used to derive the multiplier factors for GRH and for the Commuter Operations Center for the 2023 analysis. More details on these factors are provided in the GRH and Commuter Operations Center sections of this report and in the appendices detailing the calculations of those Commuter Connections programs.

FY 2021 – FY 2023 Revised Evaluation Framework

In general, the TDM analysis approaches documented in the FY 2018 – FY 2020 TDM Analysis Report were used as the basis for the evaluation methods applied in the FY 2021 – FY 2023 evaluation. But the Revised Evaluation Framework for FY 2021 – FY 2023 identified a few modifications for the current evaluation period. Additional methodological issues related to commute disruption caused by the coronavirus pandemic were encountered during the data collection and analysis phases of the evaluation process. A summary of key methodology issues and approaches is presented below by program element. Further details of each approach are presented in Sections 4 – 7 for each individual program element.

- Maryland Telework Assistance – The Telework program element is comprised of resources to help employers, commuters, and program partners initiate and expand telework programs. In evaluating teleworking, several travel changes need to be examined, including telework frequency, the mode on non-telework days, and mode and travel distance to telework locations other than home. The Telework program element includes impacts for one program in Maryland. [1]

  This program provides telework information and assistance directly to commuters who live and/or work in Maryland and to employers with Maryland worksites. Direct commute assistance impacts are estimated from the State of the Commute survey. Impacts for assisted worksites use data from surveys conducted with Maryland employers that received telework information or assistance from Commuter Connections and from the Employer Outreach database for assisted worksites that also participate as Employer Outreach clients.

  Commuter Connections also continues to provide telework information to commuters who live and/or work outside Maryland and who work for employers that do not participate in the Telework!VA program offered to employers with worksites in Virginia. Impacts of this assistance are included in the Commuter Operations Center impacts.

[1] Note: The Commonwealth of Virginia assists employers and employees with implementing telework/hybrid work schedules through the Commonwealth's Telework!VA program. The Telework!VA program is not part of the Commuter Connections program and, therefore, is not part of the TDM Analysis Report. At the end of the fiscal year, Virginia's Department of Rail and Public Transportation (DRPT) produces a report that details the activities of the Telework!VA program. Activities include the number of businesses contacted and assisted, trainings for employees and supervisors, webinars conducted, and other activities and technical assistance. In 2021, DRPT received the Innovative Transportation Solutions award from the WTS Central Virginia chapter for the Telework!VA program."

- Guaranteed Ride Home (GRH) – The basic methodology for GRH follows the format used for FY 2018 – FY 2020. This includes both new registrations and re-registrations in the program, as well as a "retained" impact component for new alternative mode GRH registrants who ended their participation in GRH prior to the start of the current evaluation period, but who continued to use alternative modes to commute into the FY 2021 – FY 2023 evaluation period. This is accomplished by estimating the number of past GRH participants and applying a "retention" placement rate and other multiplier factors to the past participant count.

- Employer Outreach – Employer Outreach impacts are estimated using the EPA COMMUTER model (v2.0) and worksite TDM program details compiled in the Employer Outreach Act! database. The model inputs require the starting mode split at the worksite, before TDM services are applied. Because most employers in the program have not conducted a baseline survey, the analysis applies default mode split distributions to these worksites, consistent with the type of employer and transit accessibility conditions at the site. These defaults are derived as the average of mode splits for employers that have conducted baseline surveys.

  In evaluations prior to 2020, the default values included baseline surveys that dated to 1997. To create default values that more closely represent current infrastructure and travel opportunities, the default values were recalculated, excluding surveys that were conducted prior to 2006. A similar update was conducted for the 2023 analysis. Additionally, more than 200 baseline worksite surveys that had been conducted by local jurisdiction staff after 2005, but which had not been entered into the employer database were incorporated into the default calculation in 2023, expanding the total number of employers on which the default values were based, and further expanding surveys that reflected more recent local conditions and raising the confidence of the default calculations. Overall, the actual default values changed only slightly, however, suggesting current baseline (pre-TDM) conditions are similar to those applied to past TDM evaluations.

- Mass Marketing – The basic methodology for Mass Marketing follows the format used for FY 2018 – FY 2020 and includes the same TDM program activities of commute program/service advertising, two promotional events (Bike to Work Day, Car Free Day), and two incentive programs ('Pool Rewards for carpool and 'Pool Rewards for vanpool). The only change in the methodology for FY 2021 – FY 2023 is the addition of a separate impact calculation for the incenTrip mobile application. Registered users of this program were included in the 2020 Placement Rate survey, enabling the consultants to derive placement rates and VTR factors for this service and calculate an impact for this service separately from other Commuter Connections services.

- Commuter Operations Center (COC) and Integrated Rideshare-Software Upgrades – The methodologies for the COC and the Integrated Rideshare-Software Upgrades follow the formats used for FY 2018 – FY 2020.

Nature of the Evaluation Approach as Compared with Other Regions

The Commuter Connections TDM evaluation approach used in the Washington DC region to assess program impacts has become recognized as among the most comprehensive and rigorous in the nation. Several regions of a similar size and complexity have adopted similar evaluation approaches.

The key characteristics of the evaluation approach used in metropolitan Washington that have elevated or enhanced the state of the practice in TDM evaluation include:

- The careful avoidance of double counting between program elements
- The derivation of unique placement rates for each program element and mode
- The inclusion of placement duration in the calculation of impacts
- The derivation of empirically-based Vehicle Trip Reduction (VTR) factors to avoid the document mistaken assumption that every new placement reduces a full vehicle trip every day
- The consideration of access mode to a shared ride arrangement to account for cold starts

For these reasons, the users of these evaluative results should feel confident that the reported impacts are as accurate and reliable as is reasonably possible and are based on what is widely accepted as one of the most comprehensive and rigorous evaluation approaches being used today in the US.

Section 4 Maryland Telework Assistance

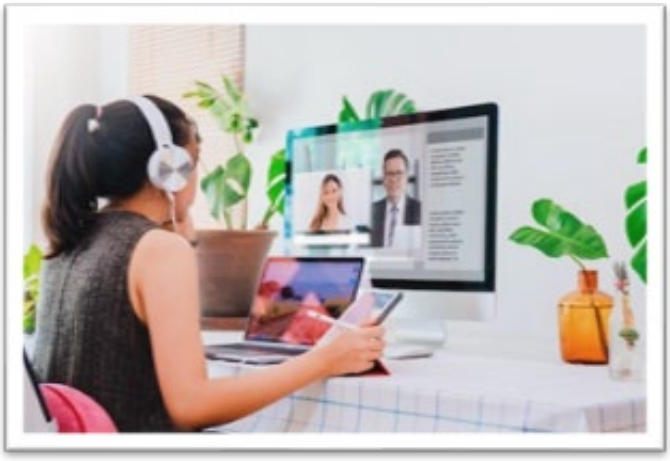
Background

The Metropolitan Washington Telework Resource Center (TRC) was implemented in June 1996. This TDM program element was renamed as Telework Assistance (Telework) in the FY 2012 – FY 2014 TDM analysis when its scope was reduced to focus solely on Maryland employers and on commuters who either lived or worked in Maryland, but its purpose remained the same: to provide information, training, and assistance to individuals and businesses to further in-home and non-home telework programs. Telework activities during the past few years have included assistance to employers to start or expand telework programs, distribution of telework information included in a telework information kit, and ongoing marketing.

Evaluation Methodology and Data Sources

The goal of Telework Assistance is to increase the number of telecommuters in the region, whether full-time or part-time telecommuters. For FY 2021 – FY 2023, Telework impacts were evaluated by calculating the number of telecommuters who used or were influenced by Telework Assistance services and estimating the number of vehicle trips and VMT they eliminated by use of telework and the tons of emissions that were reduced by the trip and VMT reductions. Through this method, only impacts that could be traced directly to Telework program element actions were counted in the analysis.

The TDM analysis has taken this conservative approach because Commuter Connections recognized that some telework would have occurred even if the Telework program element was not in place. This approach became even more relevant for the FY 2021 – FY 2023 evaluation because use of telework exploded in the region in FY 2020 and FY 2021 to accommodate coronavirus pandemic workplace shutdowns.



As reported in the 2022 State of the Commute survey report, in early 2022, 66% of regional commuters (2.14 million workers) were teleworking at least occasionally, nearly a doubling of the 2019 percentage of 35%. The average telework frequency also rose, nearly tripling to 3.37 days per week in 2022 from the 2019 average of 1.2 telework days per week. The combination of high percentage of workers teleworking and high frequency of telework produced a nearly five-fold increase in the percentage of commute trips replaced by telework in 2022, compared with 2019. In 2022, telework accounted for 48% of commute trips, compared with about one in ten trips in 2019.

Clearly, most of the telework increase was due to the pandemic but telework assistance provided by Commuter Connections was a resource used by both employers and workers to adjust to the pandemic. Additionally, because it was designed to be conservative in the credit assigned to Commuter Connections' assistance, the telework impact methodology used in past TDM analyses was fundamentally still valid for the 2023 TDM analysis, with some minor adjustments as noted later in this section.

As described below, the two components of the Telework program element impacts are analyzed similarly but using different data.

Telework Assistance Populations

Two Maryland telework populations were analyzed:

1 Commuters – Teleworkers who live and/or work in Maryland who are influenced by Telework services/assistance they receive from Commuter Connections/MWCOG to begin teleworking
2 Employers – Telework employees at Maryland worksites that are assisted by Commuter Connections

Evaluation data for these populations were obtained from several sources, each briefly described below:

State of the Commute Survey (regional commuters) – Data from the SOC survey were analyzed to estimate the:

- Number of regional telecommuters
- Telecommuters' home and work locations (45% lived and/or worked in Maryland and 55% had both home and work outside of Maryland)
- Telecommute locations – the mix between home-based and non-home-based telecommuting
- Average telecommute frequency, telecommuters' travel modes on non-telework days, and commute distance they traveled on non-telecommute days
- Telecommuters' travel patterns to telecommute locations outside the home
- Information sources used to learn about telework (COG/Commuter Connections or other)

Maryland Assisted Employer Telework Survey and Employer Outreach ACT! Contact Management Database (new telecommuters at Maryland worksites that received assistance from Commuter Connections) – Two sources were used for this population. First, a survey was sent to assisted employers asking about telework at their worksites before and after they received assistance and the role assistance played in telework changes at the worksite. Due to a small response of assisted employers in the survey, it was not possible to estimate change in telework at assisted worksites reliably. However, nearly all the assisted employers participated in Employer Outreach and details of their telework experience were included in the Act! Contact database, thus this source was used to estimate change in telework at these worksites. These two sources were analyzed to estimate the:

- Percentage of assisted worksites that recalled receiving telework assistance and that made telework program changes following the assistance
- Percentage of telecommuters at assisted sites before and after receiving assistance

To avoid double counting benefits, employers that were included in the Maryland assisted employer component were cross-checked against the list of employers that participate in the Employer Outreach program element. The telework impacts for employers that participate in both programs were subtracted from their impacts in the Employer Outreach program element, but non-telework impacts for these employers were included in Employer Outreach. [2]

[2] Telework impacts for employers that participated in Commuter Connections' Employer Outreach program and that did not receive assistance through the Maryland Telework program element are included in the Employer Outreach program element calculation, documented in Section 6. Appendix 3 provides additional explanation for how telework impacts generated through each Commuter Connections program are addressed in the evaluation.

Calculation Factors and Impacts

Placement Rates and Placements – Using results from the surveys and Commuter Connections records on assisted employers, the numbers of new telecommuters who had either direct or indirect (through their employers) contact with the Telework program element during the evaluation period were estimated.

As shown below, 58,961 placements were calculated for Maryland Telework, 58,284 from direct teleworker assistance and 677 from assistance through an employer at an assisted worksite. Maryland telecommuters were further divided into "home-based" (97% of total = 58,961) and "non-home-based" (3% of total = 1,769).

	Population base	Placement Rate	Placements
Maryland Telework			
• Maryland-based teleworkers	925,137 x	6.3% =	58,284
• Assisted Maryland worksites [3]	28,202 x	2.4% =	677

VTR Factors and Vehicle Trips Reduced – The new/increased telecommute placements were then multiplied by average VTR factors, as identified by the appropriate data, to obtain the number of vehicle trips reduced by their telecommuting. Telework element VTR factors accounted for both the average telecommute frequency of the groups as well as their travel modes on non-telecommute days. The VTR factors for non-home-based telecommuters were also adjusted for the modes these commuters used to travel to non-home telecommute locations.

- Maryland home-based telecommuters – The VTR factor was 0.43 daily trips reduced per telecommuter, reflecting the part-time (1.33 days per week average [4]) telework frequency and the elimination of vehicle trips for the 80% of telecommuters who drove alone, carpooled, or vanpooled on non-telecommute days.
- Maryland non-home-based telecommuters – The VTR factor for this group was lower (0.05) because most of these telecommuters drove alone to the non-home telecommute locations. Thus, they did not reduce (and in some cases increased) the number of vehicle trips they made on an average day. However, the benefit of their telecommuting was in the reduction of VMT on telecommute days.

Commute Distance and VMT Reduced – The VMT reduced by telecommuting was calculated by multiplying the daily vehicle trips reduced for each population by the average commute miles reduced per teleworker:

[3] The new/expanded teleworker placement rate for Assisted Maryland worksites is comprised of three elements: 1) 71% of assisted worksites recalling assistance and making a telework program change, 2) a 23% increase in telework from before to after assistance was provided, and 3) a pandemic adjustment factor of 15% (crediting Commuter Connections with just 15% of new teleworkers at assisted worksites, with 85% assumed to be entirely pandemic-related). The combination of these factors yields a credit of 2.4% of new telework assigned to the TRC (71% x 23% x 15% = 2.4%).

[4] To avoid overestimating the telework impacts credited to Commuter Connections, the Maryland telework analysis applied an average frequency of 1.33 days per week from the 2019 SOC survey rather than the 3.37 days per week average from the 2022 SOC survey. While past SOC surveys showed a steadily increasing percentage of workers who teleworked from 2007 to 2019, average telework frequency varied only slightly during these years. The large increase in telework frequency between 2019 and 2022 was attributed primarily to the coronavirus pandemic rather than to Commuter Connections actions. Thus, the analysis used the more conservative 2019 telework frequency to calculate VTR factors for Maryland Telework.

- Maryland home-based telecommuters – Average miles reduced (19.9 miles) equals the one-way commute distance to the main workplace on non-telework days.
- Maryland non-home-based telecommuters – Average miles reduced (5.8 miles) was calculated as the one-way commute distance to main work location minus the distance to the outside telework location (18.7 miles – 12.9 miles).

Emissions Reduced – Tons of emissions removed were calculated by multiplying vehicle trip and VMT reductions by 2023 emission factors developed by MWCOG staff for the Washington metropolitan region, using the MOVES emission model. Daily emissions were calculated for NOx and for VOC and annual impacts were calculated for CO2. Appendix 4 details the Telework impact calculations.

Telework Assistance Summary of Goals and Impacts

The results of the calculations for Telework are shown in the tables below. Table 6a indicates the goals established for the TW program element and the net credits or deficits, which were equal to the impacts minus goals. Table 6b presents calculation results for all regional telework; this includes both Commuter Connections-influenced impacts and those not connected to Commuter Connections.

Table 6a
Telework Goals and Estimated Telework Program Element Impacts for Maryland Telework

Table 6-a – Maryland Telework	Telework Goal – MD	Telework Impact – MD
• Number of telecommuters	31,854	58,961
• Daily vehicle trips reduced	11,830	24,681
• Daily VMT reduced	241,209	489,911
• Daily tons NOx reduced	0.1220 T	0.1072 T
• Daily tons VOC reduced	0.0720 T	0.0898 T
• Annual tons CO2 reduced	N/A	48,460.3 T

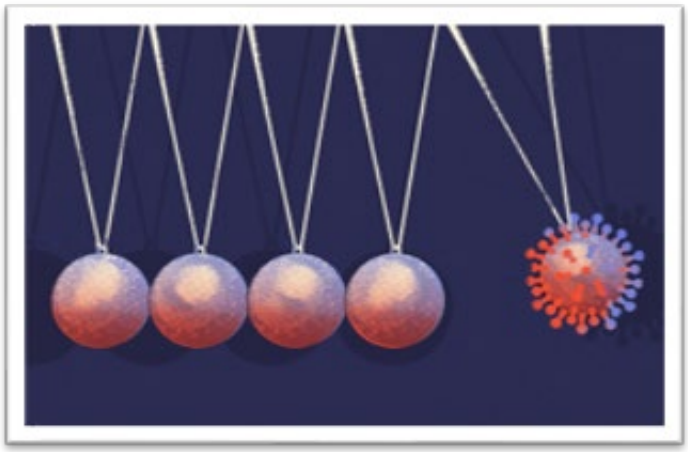
Impacts vs Goals – Maryland Telework

Participation Benefit (net over or (under) goal):	Telecommuters: 27,107
Transportation Benefit (net over or (under) goal):	Vehicle Trips: 12,851 VMT: 248,702 miles
Emission Benefit (net over or (under) goal):	NOx: (0.0148) tons per day VOC: 0.0178 tons per day

Table 6b
Regional Telework Impacts

Table 6c – Regional Telework	Regional TW Impacts
• Number of telecommuters	2,136,576
• Daily vehicle trips reduced	2,075,043
• Daily VMT reduced	34,210,775
• Daily tons NOx reduced	7.8553 T
• Daily tons VOC reduced	7.1056 T
• Annual tons CO2 reduced	3,404,225 T

Regional Telework – In 2022, more than 2.1 million regional workers teleworked at least occasionally, representing about 65% of the total regional workforce and 66% of all workers who were not self-employed, working only at home. This number of regional telecommuters represented a doubling of the 2019 count of 1,073,000, and more than seven times the 1996 baseline of 150,900 telecommuters.



Telework in the Washington region had been growing at a steady rate since the later 1990s, reflecting personal and employer-focused benefits of telework, regional transportation conditions that discouraged workers from commuting, and technological advances that made telework viable for a wider range of work types.

But the 2022 growth was an abrupt response to the coronavirus pandemic, which shut down many worksites in late March 2020. In the early months of the pandemic, the extensive use of telework in lieu of commuting was anticipated to be temporary. However, at the time of this report in mid-2023, telework remains a far more common work arrangement than pre-pandemic.

The impacts presented in Table 6b are calculated from State of the Commute data, which were collected between January and March 2022. These months, nearly two years after the start of the pandemic, represent the most accurate data available to calculate impacts during the evaluation period. However, they represent commuting and telework use at a specific point in time. Despite the pronounced increase in telework described above, even more extreme impacts might have been observed had this survey been conducted in 2020 or 2021.

Maryland Telework – Table 6a shows the expected contribution of the Maryland Telework program component to regional teleworking (Telework Goal – MD) and the impacts for this component (Telework Impacts – MD). The number of Maryland telecommuters estimated for the program element was 85% over the number of telecommuters expected from this element. The element also greatly exceeded the reduction goals for vehicle trips (109%) and VMT (103%). Maryland Telework was responsible for about 2.8% of regional telecommuters. In the 2022 State of the Commute Survey, 6.3% of Maryland telecommuters mentioned Commuter Connections or MWCOG as a source of telework information. These telecommuters were credited to the Telework program element contribution.

Section 5 Guaranteed Ride Home

Background

The Guaranteed Ride Home (GRH) Program eliminates a real or perceived barrier to use of alternative modes – the fear of being stranded without a personal vehicle in the case of an emergency. GRH provides free return transportation by taxi, TNC, Metrorail, or rental car in the event of an unexpected personal

emergency or unscheduled overtime to commuters who carpool, vanpool, use transit, or bike or walk to work at least two times per week on average. Commuters pre-register for GRH and may use the service up to four times per year. The program also allows "one-time exception" rides provided to non-registered commuters who used an alternative mode on the day a GRH trip was needed. Commuters who wish to use GRH again in the future must then register.

Evaluation Methodology and Data Sources

Transportation and emissions impacts of the GRH program were measured through two surveys, the 2022 GRH Survey and the 2021 Retention Rate survey. The GRH survey, which was conducted in the winter of 2022, assessed commute travel for commuters who participated in the GRH program during the 2023 evaluation period. The Retention Rate survey, which was conducted in spring 2021, examined commute travel for commuters who participated in GRH prior to the 2020 evaluation period.

GRH Survey

The 2022 GRH Survey polled 1,370 commuters who had registered for the Washington Regional GRH Program between March 16, 2019 and March 15, 2022 (FY 2021 - FY 2023). Both commuters who were currently registered at the time of the survey and those who had been registered at some point during the three-year period but whose registrations had expired were eligible to participate in the survey. Additionally, commuters who had not registered for the program, but had taken a "one-time exception trip" were included in the survey sample.

The survey asked detailed questions to define travel behavior changes commuters made immediately before or during their participation in GRH and the influence of GRH on these changes. Information collected from all respondents, included, among other elements:

- Commute patterns: Current mode and previous mode (if the commuter made a mode shift), frequency of mode use, travel distance, access mode to rideshare/transit pick-up point, and pool occupancy
- Permanence of mode changes: Whether change was continued (still in effect) or temporary (commuter had stopped using the new mode)
- Motivation: Importance of GRH to decisions to start or continue use of alternative modes

Data from the GRH survey were used to derive the placement rate, VTR factor, and travel distance calculation multipliers for the current/recent GRH participants. Multipliers were estimated for two GRH sub-populations, defined by participants' home and work jurisdictions. The first population included participants who lived and worked in any of the 15 jurisdictions in the Washington, DC-MD-VA ozone National Ambient Air Quality Standard (NAAQS) nonattainment area (NAA).[5] The second population included participants who worked in the NAA but lived outside it. This distinction was made because applicants who lived outside the NAA traveled a portion of their VMT outside the NAA. The average VMT for "out of NAA" applicants was discounted to include only the portion of the VMT reduction that occurred within the NAA. Approximately 37% of the total participants lived outside the NAA.

Retention Rate Survey

The 2021 Retention Rate Survey interviewed 1,316 commuters who participated in GRH or another Commuter Connections program before the FY 2018 – FY 2020 evaluation period (Pre-FY 2018). About 68% of survey respondents had registered for GRH. Data from these respondents was used to derive the GRH retained placement rate.

The objective of the survey was to identify past GRH registrants who made a change to an alternative mode to participate in GRH or while participating in GRH (alternative mode placement) and who had continued using the alternative mode after their GRH participation ended (retained in alternative modes). For this purpose, the survey included questions about, among other elements:

- Current commute pattern: Current modes, frequency of mode use, and commute distance
- Previous commute patterns: Modes used prior to joining GRH and frequency of mode use
- Motivation: Importance of GRH to continue use of alternative modes

Data from the Retention Rate survey were used to derive the retained placement rate, VTR factor, and travel distance multipliers for past GRH participants. The survey did not ask respondents about their home location, so it was not possible to calculate separate Within NAA and Outside NAA factors. Because all commuters traveled part of their commute within the NAA, it was reasonable to use an overall placement rate and an overall VTR factor for all respondents, but it was necessary to adjust the overall travel distance to include only the Within NAA portion of VMT. In past GRH surveys, the Within NAA distance was approximately 78% of the overall distance; this discount factor was applied to the overall distance from the Retention Rate survey to estimate the Within NAA factor.

Calculation Factors and Impacts

Placement Rate and Placements – Placement rate represents the percentage of GRH participant who made a shift to an alternative mode. For FY 2021 – FY 2023 program participants, the GRH placement rate was calculated for Within NAA participants and Outside NAA participants. Numerous past GRH surveys have documented that GRH participants use alternative modes considerably longer than the 36-month evaluation period. Thus, for purposes of the analysis, all GRH placements were considered continued placements. The placement rate for Pre-FY 2021 "retained" registrants was calculated from the Retention Rate survey. Because participants must have continued their use of alternative modes to be counted as retained, all the Pre-FY 2021 placements also would be counted as continued.

[5] The 15 jurisdictions included in the Washington, DC-MD-VA NAAQS nonattainment area (NAA) are: District of Columbia, Calvert County (MD), Charles County (MD), Frederick County (MD), Montgomery County (MD), Prince George's County (MD), Arlington County (VA), Fairfax County (VA), Loudoun County (VA), Prince William County (VA), City of Alexandria (VA), City of Fairfax (VA), City of Falls Church (VA), City of Manassas (VA), and City of Manassas Park (VA).

To determine the number of commuters placed in alternative modes, placement rates were multiplied by the numbers of commuters who participated in GRH in the corresponding period and location group. A total of 3,308 commuters were current participants between July 2020 and June 2023 (FY 2021-FY 2023). The count of past participants, who were registered in the Pre-FY 2021 period, was estimated to be 13,996.[6] Note that this count reflects a combination of past registrants from the Retention Rate survey for the period before July 2018, the cutoff date for the survey, plus an estimate for GRH users who ended their participation between July 2018 and June 2020.

These calculations resulted in a total of **3,445 placements**, divided as shown below, with 1,392 (40%) new placements from FY 2021 – FY 2023 GRH registrants and 2,053 (60%) retained placements from Pre-FY 2021 GRH registrants:

	Population base	Placement Rate	Placements
FY 2021 – FY 2023			
• Within NAA	2,084 x	40.9% =	852
• Outside NAA	1,224 x	44.1% =	540
Pre-FY 2021			
• Within NAA	8,799 x	14.7% =	1,293
• Outside NAA	5,167 x	14.7% =	760

Total Placements = 1,392 new placements + 2,053 retained placements = **3,445**

VTR Factors and Vehicle Trips Reduced – These placement figures were then multiplied by GRH VTR factors derived from the survey data to estimate the number of vehicle trips reduced. The VTR factors for the Within NAA and Outside NAA groups were as follows:

FY 2021 – FY 2023	
• Within NAA	0.90 vehicle trips reduced per placement
• Outside NAA	0.98 vehicle trips reduced per placement
Pre-FY 2021	
• Within NAA	0.40 vehicle trips reduced per placement
• Outside NAA	0.40 vehicle trips reduced per placement

As noted earlier, the VTR factor represents the average daily number of vehicle trips reduced by a new alternative mode placement. It combines the vehicle trip reduction contributions of various mode changes, such as from transit to carpool, drive alone to transit, and drive alone to carpool, each of which reduces a different number of daily vehicle trips, into one number. For GRH, which applies to rideshare, transit, and bicycling, VTR factors of less than 1.0 generally indicate a mix of shifts from drive alone and between alternative modes and/or reflect part-time changes to alternative modes.

The calculation of vehicle trips reduced produced a total of **2,117 vehicle trips reduced**; 1,296 vehicle trips reduced by new (FY 2021 – FY 2023) registrants and 821 from retained (Pre-FY 2021) registrants.

[6] The count of FY 2021-FY 2023 current participants reflected actual travel conditions and GRH participation during the coronavirus pandemic period. The Pre-FY 2021 past participants count, however, reflected travel during a pre-pandemic commuting period. It is likely some past participants were now teleworking/working remotely full-time. To account for this likelihood, the past participant base was adjusted downward; 30% of past participants were assumed to be no longer commuting and the base used for the calculation was 70% of the original total past participant count. Participants who were teleworking some workdays and commuting other days were included in the count.

Commute Distance and VMT Reduced – Next, VMT reduction from GRH was calculated by multiplying the numbers of vehicle trips reduced by the average trip length for GRH commuters who made a shift to an alternative mode. For the FY 2021 – FY 2023 registrants, the one-way trip distance for the within NAA respondents was 27.6 miles. The actual one-way distance for the outside NAA respondents was an average of 50.0 miles, but to discount the distance credited to the outside NAA respondents, their one-way travel distance was set equal to that of the distance for the within NAA respondents. For the Pre-FY 2021 retained registrants, the adjusted commute distance was 23.5 miles; this was used for both the Within NAA and Outside NAA groups:

FY 2021 – FY 2023
- Within NAA/Outside NAA 27.6 miles reduced per trip

Pre-FY 2021
- Within NAA/Outside NAA 23.5 miles reduced per trip

The calculation of VMT reduced produced a total of **55,063 VMT reduced**, with 35,769 VMT reduced by new FY 2021 – FY 2023 registrants and 19,294 VMT reduced by retained (Pre-FY 2021) registrants.

Emissions Reduced – Estimates of reductions in NOx, VOC, and CO2 for GRH were calculated using regional emission factors, as described for the Telework program element. Details of these calculations are shown in Appendix 5.

GRH Impacts Assigned to Mass Marketing – Note that the GRH results were adjusted to eliminate double counting between GRH and the Mass Marketing program element. About 8% of the FY 2021 – FY 2023 GRH impacts were assigned to the Mass Marketing program element to recognize that some GRH applicants were influenced to contact Commuter Connections and apply for GRH after they heard a Mass Marketing advertisement. The impacts shown in Table 7 account for the adjustment and reflect the net GRH impacts.

GRH Summary of Goals and Impacts

Table 7 presents the transportation and emission impact results for GRH and compares the results against the goals established for the program element. During the FY 2021 – FY 2023 evaluation period, 3,308 commuters participated in GRH; this represents just 18% of the GRH participant goal. The vehicle trip reduction and VMT impacts also fell below the goals, although the retained impact from past registrants who continued to use alternative modes even after leaving the program somewhat offset the shortfall from current registrants. Vehicle trip and VMT impacts were 32% and 29%, respectively of the goals, compared with 18% for participation.

Participation in GRH dropped steadily between 2005 and 2020. Past TDM analyses have noted possible reasons, including commuters feeling less concerned about being stranded because they have a greater number of travel options and a decline in regional awareness of the program. But the decline noted between the 2020 analysis and 2023 analysis was dramatic; participation declined from nearly 13,000 participants during FY 2018 – FY 2020 to only 3,308 during FY 2021-FY 2023. Applications dropped off abruptly in spring 2020, at the start of the coronavirus pandemic, and remained at a low level throughout the evaluation period. It is likely that many of the commuters who did not renew their GRH registrations were either working from home full-time or most of their workdays. In the 2022 GRH survey, 41% of all past registrants cited working from home as a reason to leave the GRH program.

Table 7
Guaranteed Ride Home Goals and Estimated Impacts

	GRH Goal	Estimated Impacts
• Number of GRH participants (June 2023)	18,496	3,308*
• New applicants during evaluation period	N/A	1,568
• Number of past participants (Pre-FY 2021)	N/A	13,966
• Daily vehicle trips reduced	6,296	2,013
• Daily VMT reduced	177,568	52,201
• Daily tons NOx reduced	0.0890 T	0.0088 T
• Daily tons VOC reduced	0.0480 T	0.0054 T
• Annual tons CO2 reduced	N/A	4,529.5 T

* Number of participants who re-registered during FY 2021, plus new registrants between FY 2021 - FY 2023.

Impacts vs Goals

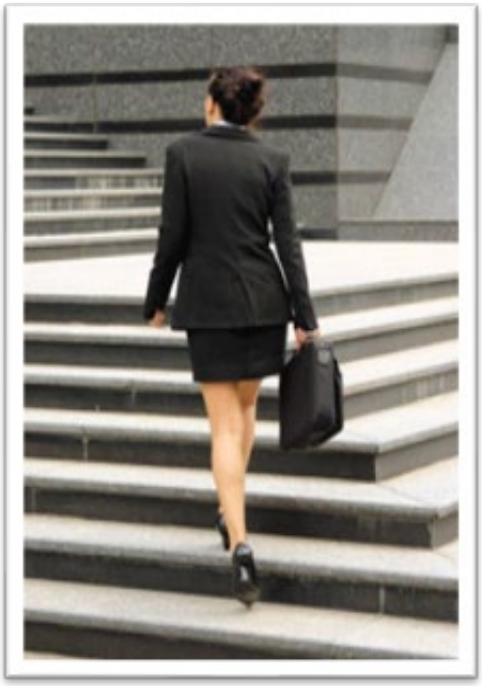
Participation Benefit (net over or (under) goal): Participants: (15,188)

Transportation Benefit (net over or (under) goal): Vehicle Trips: (4,283)
VMT: (125,367 miles)

Emission Benefit (net over or (under) goal): NOx: (0.0802 tons per day)
VOC: (0.0426 tons per day)

Section 6 Employer Outreach

Background



The Employer Outreach program element is designed to encourage employers to implement new commute assistance programs and to expand the services they offer in existing programs. In this element, jurisdiction-based sales representatives contact employers, educate them about the benefits commuter assistance programs offer to employers, employees, and the region, and assist them to develop, implement, and monitor worksite commuter assistance programs.

A share of the funds received by COG for the Employer Outreach program element is passed-through to the jurisdictions for implementation of the program. Commuter Connections assists the sales force with the following services, designed to enhance regional coordination and consistency:

- Web-based regional employer contact database
- Marketing and information materials
- Employer outreach sales and sales force training
- Annual evaluation program
- Support to Employer Outreach Committee
- Employer satisfaction survey

Evaluation Methodology and Data Sources

Employer Outreach is aimed at increasing the number of private employers implementing worksite commuter assistance programs, but Employer Outreach is ultimately designed to encourage employees of client employers to shift from driving alone to alternative modes.

Two primary evaluation questions are thus important. First, how many employers start or expand commuter assistance programs? And second, how many employees use alternative modes in response to new employer-sponsored services at the worksite? These two variables are strongly linked, as other TDM effectiveness research has shown. Higher levels of employer effort can be expected to offer greater incentive to employees to use alternative modes, leading to reductions in vehicle trips, VMT, and emissions.

The populations of interest for this program element are:

- Employers that participate in Employer Outreach
- Employers that offer bicycle services (Employer Outreach for Bicycling)
- Employees at Employer Outreach worksites
- Employees at worksites that offer bicycle services

Employer Participation in Commute Programs

The employer participation component of the analysis was assessed through data collected by Commuter Connections from sales and outreach contacts with employers. Employer Outreach jurisdiction sales representatives documented the levels of programs implemented by their employer clients in the ACT! contact management database maintained by Commuter Connections. The Employer Outreach program specified services employers offered, for example, transit subsidy, information/promotions, Guaranteed Ride Home, etc.

The Employer Outreach program defined four levels of employer effort: Bronze (Level 1), Silver (Level 2), Gold (Level 3), and Platinum (Level 4), distinguished by the expected increasing trip reduction effectiveness of the services offered and the commitment of the employer, as shown below. [7]

- **Level 1 (Bronze1) programs** offer only commute information and/or electric car charging stations.
- **Level 2 (Silver) programs** offer two or more commute support services, such as: Employee Transportation Coordinator (ETC), preferential parking, carpool/vanpool formation meetings, bike racks or lockers, Capital Bikeshare Corporate Partner, transportation fairs, telework program with 1-20% of employees participating, and compressed work schedule with 1-20% of employees participating.
- **Level 3 (Gold) programs** include, in addition to the Level 2 services, at least one of services such as transit subsidy or parking "cash out," telework program with more than 20% of employees participating, parking fee discount for carpool/vanpools, shuttle to transit stations, comprehensive bicycle/walking program, and company vanpools.
- **Level 4 (Platinum) programs** include two or more of the Level 3 program components, at least two Level 2 strategies, and actively promote the program.

When the Employer Outreach program element was adopted, the TPB established a goal to be achieved by June 2005 and evaluations conducted for periods through June 2005 measured impacts against this goal. Beginning with the 2005-2008 analysis, new Employer Outreach goals were established for the overall program and for new program activity during the evaluation period. Thus, for the FY 2021 - FY 2023 evaluation, impacts were calculated for "continued" employer programs and "new/expanded" programs.

Continued impacts included employers that joined EO before July 1, 2020 and made no changes since that date. Expanded impacts included employers that were involved in EO before July 1, 2020 but expanded their commute assistance services after that date. New impacts included employers that joined the EO program on or after July 1, 2020. A final category was defined to calculate the impacts of employers that were included in the FY 2018 – FY 2020 evaluation but dropped out of EO before June 2023. Commuter Connections determined that the impacts that would have been credited for these employers would have to be replaced by new/expanded impacts. Impacts were estimated for the following groups of employers:

- Continued – June 2020 employer programs continued with no change
- Expanded – June 2020 employer programs expanded since June 2020
- New – Employer programs started since June 2020
- Deleted – June 2020 employer programs deleted between July 2020 and June 2023

[7] For more details of employer levels, see Appendix 6.

EO participation by these four employer groups had been reported also in past evaluations but one adjustment was made in the 2023 analysis of expanded programs to account for increased reporting of telework as a worksite program change. While some employers expanded the amount of a transit pass or the availability of carpool or transit support services, the EO analysis identified a large group of employers that expanded only the telework component of the program. These "expanded telework" employers were analyzed as a separate group, because it was assumed that while EO account representatives might have provided information or assistance that smoothed the telework expansion, the telework increase was predominately prompted by workplace shutdowns related to the coronavirus pandemic. For employers that expanded telework and for employers that started a new telework program, only 10% of new telework impact was assigned to the EO program. The remaining telework increase was assumed to have been related only to the pandemic, rather than to EO actions.

The overall benefit of the program is the sum of continued programs plus expanded and new programs. As shown below, in June 2023, the Act! database included 2,166 employers with programs that met the Level 3 or 4 definitions. These employers accounted for 512,945 employees. Level 1 and 2 employers were not included in the regional impact calculation because their level of impact would be very small due to the absence of financial incentives or other substantial commute support services.

Of the Level 3 and 4 employers, 989 joined Employer Outreach prior to July 2020 and made no program changes since then. The expanded category included 432 employers, 378 that made only telework changes and 54 that expanded non-telework services. A total of 745 employers were listed as "new" since June 2020.

The analysis also accounted for the loss of 573 employers that were counted in the 2020 evaluation and that were no longer involved in the program. These employers accounted for 106,406 employees. Had the deleted employers continued in the program, the total employee count would have been 619,351, so they represented a drop of about 17% in total employees in the program. The deleted employee count was slightly lower than the 109,876 employees at new EO worksites, so new employers entirely replaced the deleted employers.

Note that the count of deleted employers reflects an effort by COG/TPB staff and local jurisdiction staff to purge the database of employers that had ceased operations, had moved from the region, and/or were no longer actively involved in the Employer Outreach program. Further, it is likely that some employers that left the EO program did so because they shifted largely or entirely to remote work, so worksite commute services were no longer useful or important benefits to offer employees.

	Number of Employers			Number of
Employer Status (June 2023)	**Total**	**<100**[1)]	**100+**	**Employees**
- Continued/unchanged vs June 2020	989	562	427	264,819
- Expanded non-telework after June 2020	54	24	30	21,562
- Expanded only telework after June 2020	378	203	175	116,688
- New programs since June 2020	745	469	276	109,876
Total	**2,166**	**1,258**	**908**	**512,945**
Deleted from 2020	573	309	264	106,406

1) Actual number of employers with fewer than 100 employees.

Employee Participation in Commute Programs

Use of COMMUTER Model in Estimating EO Impacts – The second variable in the impact evaluation, employees' response to services offered, was more difficult to obtain. Starting mode split data were available for only about one-quarter of the employers, those that had conducted a baseline commuter survey prior to implementing the TDM program. But as is typical for voluntary programs, only a few had conducted a follow-up survey by the time the evaluation data were being collected. Because baseline data were available, but post-program survey data were not, the researchers elected to estimate employee behavior changes using the US EPA's COMMUTER Model v 2.0, which estimates worksite mode shifts from inputs on starting mode split and TDM program components. This was the same methodology as was used in the 2020 evaluation.

In 2022, the research team examined several other models to determine if any feasible options existed that would be as reliable and efficient as the COMMUTER model for the EO analysis. This review found that none of the alternative models offered both the capability to analyze the wide range of TDM strategy combinations that were implemented by EO employers as well as the capability to analyze efficiently impacts for individual employers. The research team previously developed a technique to run the COMMUTER model for large numbers of individual employers in "batch" mode, allowing an independent impact analysis for each employer, in a highly efficient process. Without this capability, it would be cumbersome to analyze the large number of employers in the EO analysis. Thus, the COMMUTER model was used for the FY 2021 – FY 2023 EO calculation.

The COMMUTER Model uses time and cost coefficients that are compatible with coefficients used by MWCOG in regional transportation modeling. In 2007, COG and the evaluation team adjusted the cost coefficients used in the model, to correct for the COMMUTER Model's tendency to overestimate the likely impacts of financial incentives on shifts to non-SOV modes. These coefficients were used for the 2008 and 2011 evaluations.

During 2010-2012, MWCOG developed a new regional travel model. MWCOG modeling staff reviewed the COMMUTER Model cost and time coefficients used in the 2011 evaluation and concluded that no further adjustments were needed for 2014 or 2017 to be consistent with the new regional model. MWCOG continues to use this regional model and the model continues to evolve, thus the research team reviewed regional model guidance documents prepared by the MWCOG modeling staff to determine if any changes made to the regional model might indicate a needed change in the COMMUTER model coefficients to remain compatible with the regional approach.

That review found numerous model modifications, but none that would affect the validity of the current coefficients applied in the COMMUTER Model. Most of the regional model changes were made to improve the efficiency and speed of the operation of the model, rather than the model results. And the changes that did alter the model results primarily adjusted assumptions related to bike and walk access to transit, particularly in suburban areas. As these changes were not cost related, the research team concluded that the coefficients used for the EO analysis in 2020 could be carried over to the 2023 evaluation.

Starting Mode Split – The COMMUTER model v 2.0 requires several "scenario" inputs, including the type of employer (primarily office or non-office occupations) and the starting mode split. For employers that had conducted a baseline, "pre-program" survey, the actual mode split from the survey was used as the input. But for employers that had not conducted a survey, a starting mode split was assigned that reflected the average mode split that would be likely for employers with similar location and employee work conditions.

These average mode splits were calculated by aggregating employers in the Act! database that had conducted baseline surveys into six groups, based on two employer/site variables that are known to influence mode choice: 1) type of employer/work performed, either office or non-office, and 2) availability of transit service: low, moderate, or high. Low transit was defined as limited bus service within ½ mile of the worksite. Moderate transit included a higher level of frequency and route availability. To be designated as a "high transit" employer, the site had to be within ½ mile of a Metrorail station and have access to a significant level of bus service. For each of the six combinations of these two variables, for example, non-office employers with high transit and office employers with moderate transit, an average mode split was calculated from the baseline survey data of employers in that employer group that had conducted commuter surveys.

In evaluations prior to the 2020 analysis, the default values included baseline surveys that dated to 1997. To create default values that more closely represent current infrastructure and travel opportunities, the default values were recalculated, excluding surveys that were conducted prior to 2006. The default mode splits were again updated in 2023, with data from approximately 200 additional baseline worksite surveys that had been conducted by local jurisdiction staff after 2005, but which had not been entered into the employer database. This expanded both the total number of employers on which the default values were based and increased the sample of surveys that reflected more recent local conditions, raising the confidence of the default calculations. Overall, the actual default values changed only slightly, however, suggesting current baseline (pre-TDM) conditions are not dramatically different than those applied to past TDM evaluations.

Program Definition – The TDM analysis also classified employers by the specific commuter program services they offered. The COMMUTER model v 2.0 permits direct analysis of strategies that change the travel cost of a mode (e.g., transit subsidies), and strategies that change the duration of a trip (e.g., express transit service).

The model also has the capability to predict impacts of telework and compressed work schedules (CWS), when certain parameters of the work hour arrangements are known. The Act! database indicated employers that had a telework program. Some records noted the actual number of employees at the worksite who were teleworking, enabling a precise percentage of teleworkers to be calculated. Employers that offered telework, but for which participation numbers were not available were assumed to have telework rates equal to the average rates for their industry (North American Industry Classification System – NACIS codes), as defined by the U.S. Census' American Community Survey 2021 data.[8] The Act! database also noted employers that offered CWS. When participation counts were missing for these employers, a default percentage calculated from the 2022 State of Commute survey was assigned.

Other commute strategies, such as GRH, flextime, information support, and preferential parking, all are treated by the model as elements in a "support package." They are not modeled separately. Rather the level or extent of the support service package is modeled and the higher the number of these strategies offered, the higher the level of support that is modeled.

The strategy package assigned to an employer was thus comprised of the following potential actions:

- Amount of mode-specific financial incentives (transit, carpool, vanpool, bicycle)
- Amount of parking fee discounts (rideshare parking discount, parking cash out)

[8] *Steven Ruggles, Sarah Flood, Matthew Sobek, Danika Brockman, Grace Cooper, Stephanie Richards, and Megan Schouweiler. IPUMS USA: Version 13.0 [dataset]. Minneapolis, MN: IPUMS, 2023. https://doi.org/10.18128/D010.V13.0 Accessed May 23, 2023.*

- Estimated percentage of telecommuting employees (actual or assumed percentage)
- Estimated percentage of employees working a compressed schedule (actual or assumed percentage)
- Level of alternative mode commuter support (e.g., ridematching, mode information, employee transportation coordinator, Guaranteed Ride Home, preferential parking, flextime, vanpool formation support)
- Availability of bicycle services
- Availability of a shuttle bus or contracted ridehail service to Metrorail or other transit location

Calculation of Vehicle Trip Reduction – The COMMUTER model v 2.0 was run in a batch format that allowed each employer's program components to be modeled separately. The analysis thus calculated for each employer the final mode split with the program in place. By comparing the starting and ending mode splits, the percentage trip reduction that would be expected following implementation of the program elements was calculated. This trip reduction was then applied to the number of employees at the worksite to estimate the number of vehicle trips reduced for that employer.

An additional note is needed to explain how vehicle trips reduced by teleworking/telecommuting were calculated. As noted earlier, the share of EO employers that were reported to offer telework was higher in 2023 than in 2020; 54% of employers in the EO analysis reported telework as a worksite program, compared with 36% of employers in the 2020 EO analysis. The percentage of teleworking employees at sites that offered telework also had increased; in 2023, 40% of worksites with telework reported 20% or more employees teleworking, compared with just 6% of worksites in 2020. Finally, the average telework frequency, as estimated from the State of the Commute surveys more than doubled, from 1.2 days per week in 2019 to about 3.4 days per week in 2022.

When these three factors are combined, they would result in vehicle trip reduction from telework that was dramatically higher in 2023 than in 2020. But much or most of the telework increase between 2020 and 2023 would have been due to the coronavirus pandemic. To avoid overestimating the telework impacts, the analysis calculated telework impacts for continued programs, which had not reported telework changes, using their 2020 telework percentages and the 2020 average telework frequency.

This approach acknowledged the EO program's role in past telework growth but took no credit for additional telework frequency that was pandemic-related. Similarly, worksites that reported expanded telework were credited with the 2020 base telework impact and only 10% of additional telework[9]. And the EO program was credited with 10% of telework impacts that were offered at new worksites. Finally, to ensure that the motivating influences of non-telework strategies, such as transit subsidies and carpool support services were not overestimated, the vehicle trip reduction predicted by the COMMUTER model for these strategies were applied to a reduced base of workers at the worksites, reflecting the shift of some workers to full-time and/or frequent telework.

Calculation of VMT Reduction – Because travel distance was not available for either individual employees or employers in the Act! database, the number of VMT reduced was estimated by

[9] Analysis of State of the Commute (SOC) surveys from 2010, 2013, 2016, and 2019 found that the number of regional teleworkers had increased by an average of 12% in each three year period between the survey years (2010-2013, 2013-2016, 2016-2019). Additionally, each SOC survey identified additional potential for telework among non-teleworkers who had telework appropriate work responsibilities and a desire to telework. Thus, it seemed reasonable to expect some expansion of telework at EO worksites even in the absence of the pandemic. To be conservative, the analysis assigned 10% of new teleworkers to the efforts of Employer Outreach; the remaining 90% was assumed to be pandemic related and was excluded from the EO impacts.

multiplying the vehicle trips reduced for an employer by the average regional one-way trip lengths for each mode, as measured through the 2022 State of the Commute Survey. Emissions reduced were calculated by multiplying trips and VMT reduced by 2023 regional emission factors provided by COG staff. Finally, the individual results for each employer were aggregated to estimate the combined impact of all employers in the program element. Appendix 6 provides details of the calculations of impacts for Employer Outreach.

Employer Outreach Summary of Goals and Impacts

The impacts calculated as described above, were compared against the EO program element goals. The total goals and impacts are shown in Table 8.

Table 8
Employer Outreach Goals and Estimated Impacts

	EO Goal	Estimated Impacts
Employer Outreach (all programs)		
• Employers participating - total	2,031	2,166
– Continued from 2020	No goal	989
– Expanded after 2020	No goal	432
– New in 2023	91	745

• Total employers and employees by jurisdiction and count of new/expanded employers

	Total Employers	Employees	New/Expanded Employers
– Alexandria, VA	167	24,421	78
– Arlington County, VA	328	51,331	137
– District of Columbia	302	73,480	79
– Fairfax County, VA	659	215,646	514
– Frederick County, MD	32	12,056	22
– Loudoun County, VA	30	18,271	19
– Montgomery County, MD	496	79,913	211
– Prince George's County, MD	45	14,930	27
– Prince William County, VA	44	10,974	32
– Tri-County Council, MD	63	11,923	58

• Total employers and employees by size category and count of new/expanded employers

	Total Employers	Employees	New/Expanded Employers
– Sites with 100+ employees	908	469,988	481
– Sites with less than 100 employees	1,258	42,957	696
– "Equivalent 100+" [1)]	429		70

1) Employers with fewer than 100 employees are grouped into "equivalent 100+" employers. The 1,258 employers in this category employ 42,957 employees, thus represent 429 "equivalent 100" employers (42,957 / 100).

Table 8 (continued)

Impacts vs Goals

Overall Employer Outreach Program

	EO Goal	Estimated Impacts
Total Program		
• Daily vehicle trips reduced	90,776	69,498
• Daily VMT reduced	1,533,161	1,247,480
• Daily tons NOx reduced	0.6170 T	0.2571
• Daily tons VOC reduced	0.3850 T	0.2056
• Annual tons CO2 reduced	N/A	119,083.0 T

Participating Employers (net over or (under) goal): Employers: 135

Transportation Benefit (net over or (under) goal): Vehicle Trips: (21,278)
VMT: (285,681) miles

Emission Benefit (net over or (under) goal): NOx: (0.3599) tons per day
VOC: (0.1794) tons per day

New / Expanded Employer Programs

	EO Goal	Estimated Impacts
• Combined new/expanded programs	N/A	1,177
– New programs	N/A	745
– Expanded non-telework programs	N/A	54
– Expanded telework programs	N/A	378
• Daily vehicle trips reduced	N/A	10,946
• Daily VMT reduced	N/A	198,638
• Daily tons NOx reduced	N/A	0.0408 T
• Daily tons VOC reduced	N/A	0.0325 T
• Annual tons CO2 reduced	N/A	18,963.0 T

Participating Employers (net over or (under) goal): Employers: No goal for comparison

Transportation Benefit (net over or (under) goal): Vehicle Trips: No goal for comparison
VMT: No goal for comparison

Emission Benefit (net over or (under) goal): NOx: No goal for comparison
VOC: No goal for comparison

As shown, even with the loss of 573 employers that left the EO program since 2020, the overall number of employers participating in the program exceeded the participation goal by 7%, due to the addition of 745 employers that were new to Employer Outreach. The EO program fell short of the vehicle trip reduction and VMT reduction goals, by 23% and 19%, respectively, however. This was due to three factors. First, employers that left the EO program typically offered more substantial services than did the

new and expanded EO employers. Many of the employers in the new category offered telework but few other TDM services and more than eight in ten expanded employers expanded only telework, so their non-telework impact on commuting behavior would be minimal. Second, to ensure the analysis did not overestimate the EO program's role in telework growth, the analysis credited EO with only 10% of new and expanded telework impacts, assigning 90% to "the pandemic." Thus, impacts from new and expanded employers contributed less to the total EO impact than has typically been the case in past evaluations. The final reason for the shortfall in vehicle trip and VMT impacts is that the COMMUTER model estimates for commute changes from non-telework TDM strategies, such as transit subsides, would have been applied to the base of employee commute days, with telework days excluded. Because telework use was much higher in 2023 than in 2020, the base of commute days was lower than in 2020.

Employer Outreach for Bicycling

A similar calculation was made to estimate the contribution of bike strategies to Employer Outreach program impacts. This program element provides regional outreach to encourage employers to implement worksites strategies that encourage employees to use bicycling for commuting. A total of 732 employers offered bicycle strategies in their worksite programs in 2023. The impacts for these employers were modeled "with bicycling" and "without bicycling." The difference in vehicle trips reduced between these two cases was assigned as the bike strategies' share of the impacts. It was assigned to the Employer Outreach for Bicycling component of Employer Outreach.

The VMT reduced for bicycling was estimated by multiplying the vehicle trips reduced by an average one-way trip length for bicycle commuters, of 4.5 miles, calculated from the 2022 State of the Commute (SOC) Survey.

The Employer Outreach for Bicycling program element exceeded the goal for the number of employers offering bike strategies and just met the vehicle trip reduction goal but missed the VMT reduction goal by 25%. EO for Bicycling fell short also of the goals for VOC and NOx reductions established for the program (Table 9).

Table 9
Employer Outreach – Bike Services Goals and Estimated Impacts

	EO Goal	Estimated Impacts
• Employers with bike strategies	590	732
• Daily vehicle trips reduced	404	405
• Daily VMT reduced	2,421	1,823
• Daily tons NOx reduced	0.0016 T	0.0007 T
• Daily tons VOC reduced	0.0015 T	0.0011 T
• Annual tons CO2 reduced	NA	198.3 T

Participating Employers (net over or (under) goal): Bike Employers: 142

Transportation Benefit (net over or (under) goal): Vehicle Trips: 1
VMT: (598) miles

Emission Benefit (net over or (under) goal): NOx: (0.0009) tons per day
VOC: (0.0004) tons per day

Section 7 Mass Marketing

Background

In 2003, Commuter Connections embarked on an ambitious effort to educate the region's commuters about alternatives to stress-filled solo commuting and to raise awareness of commute assistance services available through Commuter Connections and its partners. Radio, television, social media, digital media, direct mail, transit advertising, and other media are used to create a new level of public awareness and to provide a call to action to entice commuters to switch to alternative modes.

The objectives of the Mass Marketing program element are to:

- Raise regional awareness about the Commuter Connections brand
- Address commuters' frustration with congestion
- Induce commuters to try and adopt alternative commute modes

The FY 2021 – FY 2023 Mass Marketing analysis also includes impacts for two annual commute events: Bike To Work Day event and Car Free Day event, and three regional incentive programs: 'Pool Rewards carpool incentive, 'Pool Rewards vanpool incentive, and the incenTrip mobile application. Commuter Connections' role in these events is regional and primarily promotional in nature, so their impacts are most appropriately included in the Mass Marketing program element calculation.

Evaluation Methodology and Data Sources – Umbrella Marketing Campaign

The Mass Marketing program element has seven populations of interest:

1) All commuters in the Commuter Connections service area
2) Commuter Connections rideshare applicants who were influenced by the marketing campaign to request Commuter Connections services
3) GRH applicants who were influenced by the marketing campaign to request Commuter Connections services
4) Commuters who participated in the incenTrip reward and trip tracking mobile application
5) Commuters who participated in the 'Pool Rewards carpool and 'Pool Rewards vanpool incentive programs
6) Commuters who participated in the Bike To Work Day event
7) Commuters who participated in the Car-Free Day event

The Mass Marketing element presents two challenges not encountered in most of the other program elements. First, it is more difficult to assess the influence of a strategy, such as a marketing campaign, that is applied to the general commuting public, than it is to identify and track known participants in a registration-based program such as GRH. Second, when commuters who changed travel behavior can be identified, it is still necessary to identify what motivated their change. The critical issue for this element

is identifying and attributing reported changes in attitudes and behavior – to the mass marketing campaign, another program element, or to some other outside influence.

Types of Changes Addressed – The Mass Marketing advertising evaluation method examines impacts from two types of commute mode changes, which are measured separately. The first, ***"directly"*** influenced mode changes, occur when ads motivate commuters to change mode with no intermediate contact with Commuter Connections. An example of this type of change would be a carpool formed when a commuter hears an ad and asks a co-worker to carpool.

Direct influences can only be assessed through a regional survey of commuters that asks about mode changes and the reasons for the changes. If a shift occurred and the shift can be attributed to a Mass Marketing campaign message, the associated trip, VMT, and emissions reductions can be credited to the campaign. Note that this calculation needs to correct for double counting with commuters who also cite influence of other program elements on their travel change.

The second, "***referred***" mode changes, result when a commuter is influenced by an ad to contact Commuter Connections, such as when a commuter hears a radio ad for GRH and registers for the program. This type of change would include, for example, a commuter who hears the ad, requests a ridematch from Commuter Connections, then forms a new carpool as a result. Under the evaluation method, any mode change the commuter makes in response to GRH would be defined through the GRH assessment, but a portion of the influence for that change would be credited to Mass Marketing, which provided the information about GRH.

Referred influences are assessed by tracking changes in the volume of web, phone, and other requests for information about GRH, ridematching, events, and other Commuter Connections services. Comparison of the volumes of requests received during periods of media activity to periods without media activity can provide an indication of the mode change result of the ads. A pro-rated share of the impacts of these other program element impacts then can be assigned to Mass Marketing and be subtracted from GRH or COC impacts to avoid double counting.

Evaluation of Direct Influence

Directly influenced change is measured for this evaluation through the 2022 regional State of the Commute survey, which included questions related to the following:

- Ad awareness – Were commuters aware of commute advertising and the specific messages conveyed and could the source of the ad be reasonably assigned to Commuter Connections?
- Changes made after hearing the ads – How many commuters who recalled Commuter Connections' ad messages shifted to alternative modes after hearing the ads and how were they traveling before the change?
- Reasons for change – Did the ads influence the commuters to make the change?
- Other commute services used – Did the commuters use any commute services provided by Commuter Connections?

Results for these questions were used to estimate the number of regional commuters who were influenced by ads to change mode without contact with Commuter Connections. The survey results were as follows:

Percentage of commuters who:

- Recalled Commuter Connections ad message 5.9%

Commuters who recalled specific commute messages were asked about actions and influences related to the ads. Among respondents who recalled Commuter Connections messages, the surveyed indicated:

- Shifted to an alternative mode after hearing CC ads 14.8%
- Said the ad influenced their decision to shift 50%
- Did not use any other Commuter Connections or employer service 100%
- **Resulting influence percentage from CC ads[10] 0.437%**

Thus, 0.437% of regional commuters were directly influenced to make a change. This percentage was multiplied by the number of regional commuters (2,055,050) to estimate 8,973 alternative mode placements. [11]

Further analysis of survey respondents who made a change showed that 28% continued using the new mode and 72% were temporary or occasional users. Respondents who made changes reduced an average of 0.65 vehicle trips per day with their changes. These factors, and the 21.0 mile per trip distance calculated from the State of the Commute data were applied to the total number of new alternative mode placements to obtain the numbers of vehicle trips and VMT reduced by direct influence.

Evaluation of Referred Influence to the Commuter Operations Center and GRH

In prior TDM analyses, indirect influences of Mass Marketing were estimated through comparison of the volume of requests made to the Commuter Connections by telephone, website contact, and social media response, and the numbers of ridematch and GRH applications received:

- In months when MM ads/actions were aired
- In months when MM ads/actions were NOT aired

The analysis calculated the average numbers of inquiries and applications received during "with MM' and "without MM" periods and compared the numbers. An increase in requests observed during the "with MM" periods was assumed to result from the ads and other marketing efforts performed during the same time periods. Thus, the analysis also calculated volumes of website, phone, and social media information requests (CC inquiries) that were received under "with ad" and "without ad" scenarios.

[10] Influence percentage was calculated as percentage of commuters who recalled CC ad message x percentage who shifted to an alternative mode x percentage who were influenced by ad to shift x percentage who did not use other CC services = 5.9% x 14.8% x 50% x 100% = 0.437%

[11] The count of regional commuters (2,055,050) includes only workers who travel to a worksite outside their homes at least one weekday per week. This count excludes workers who telework full-time, are self-employed and work only at home, and workers who work only on weekends. In 2022, these excluded workers represented 1,273,784 workers, or about 38% of all workers in the region.

This analysis was complicated in the FY 2021 – FY 2023 evaluation by the coronavirus pandemic, during which time both commute travel and Mass Marketing outreach were substantially disrupted. Commuter Connections paused much of its typical MM advertising campaigns throughout FY 2021. In FY 2022, Commuter Connections resumed promotion for special events, such as Car Free Day and Bike to Work Day and undertook new pandemic-focused advertising such as "Commute with Confidence" and "Look Again" to reassure commuters that travel by transit and rideshare was safe. While these efforts would have acquainted commuters with Commuter Connections and promoted a return to non-drive alone modes, the relationship between ad campaigns directed to ridesharing and GRH actions taken by commuters are less direct than in past evaluations.

Three other factors also are notable for the MM referred influence for both GRH and the Commuter Operations Center. A sizeable share of MM advertising is now directed to promoting incentive programs (CarpoolNow, incenTrip, 'Pool Rewards, and Flextime Rewards). MM involves more outreach partners, who promote TDM services, including Commuter Connections, throughout the year. And Commuter Connections utilizes a wide range of media formats, with a greatly expanded use of social media compared with the primary radio and print/mailed outreach prior to the 2017 TDM analysis. The 2017 and 2020 analyses added event and incentive program outreach to the Mass Marketing tracked advertising and added social media "clicks" to the phone calls, web contacts, and COC/GRH registrations that served as commuters' "response" to MM calls to action.

Coupled with the commuting and advertising disruption due to the pandemic, the results of the "with ad" vs "without ad" analysis that was used in past evaluations did not seem reliable for the FY 2021 – FY 2023 evaluation for either the Commuter Operations Center or Guaranteed Ride Home. But it seems reasonable that Mass Marketing advertising did influence use of the Commuter Connections resources via the Internet, 800 telephone number, and mobile applications.

GRH Referred Influence – The 2022 GRH survey included questions directly asking respondents if they recalled GRH advertising and if the advertising had influenced them to register for GRH. About one-quarter (26%) of GRH applicants said they heard advertising and were influenced to register. When this influence percentage was applied to the 31% share of total GRH impacts generated by commuters who joined GRH during the evaluation period (July 2020-June 2023), it resulted in about 8% of the FY 2021 – FY 2023 GRH impacts being assigned to the Mass Marketing program element as a referred influence.

Commuter Operations Center Referred Influence – A similar approach was taken to estimate what portion of the Commuter Operations Center impacts were related to MM actions. The 2020 Applicant Placement Rate survey asked registrants how they learned of Commuter Connections; about 20% reported a source that would be a MM action. When applied to the 11.0% of total assisted commuters who were new to the Commuter Operations Center during the evaluation period, it resulted in about 2.2% of COC credit being assigned to MM.

Evaluation Methodology and Data Sources – 'Pool Rewards Program

Impacts for the third component of this program element, 'Pool Rewards carpool and 'Pool Rewards vanpool incentives, were calculated in a manner like that used for the GRH program element. The numbers of carpool and vanpool participants were multiplied by placement rate, VTR factor, and travel distance calculation multipliers specific to the carpool and vanpool programs to estimate the travel impacts. Data to derive the carpool multipliers were collected through three tools: mode tracking required of all participating commuters and two post-program surveys. Data for the vanpool multipliers were estimated from data collected by MWCOG staff on each vanpool for submittal to the National Transit Database (NTD).

'Pool Rewards Carpool Program

Since the program was open only to commuters who were driving alone prior to the program, all 'Pool Rewards carpool participants were placed in a new mode. 'Pool Rewards is a short-term incentive program but has a long-term potential if participating commuters continue using alternative modes after their program enrollment ends. Commuter Connections has conducted several surveys to estimate both short-term term retention (2011, 2017, 2020). A June 2023 survey examined both short-term and long-term retention by interviewing commuters who participated between July 2020 and June 2023 (current evaluation period) and commuters who participated before July 2020.

Placement Rates and VTR Factors – As of June 2023, 305 commuters had completed the 'Pool Rewards carpool program; 33% (101) participated during the FY 2021 – FY 2023 evaluation period and 67% (204) completed the program prior to July 2020. The 2023 survey, which was administered to both groups, found that 71% of commuters who participated during FY 2021 – FY 2023 were still carpooling and 98% were still using an alternative mode at least one day per week. These results were used to derive the long-term carpool retention placement factors: 98% continued placement and 2% temporary placement for recent participants. Among commuters who participated prior to July 2020, 54% were still using alternative modes, thus, a retained placement rate was 54% for these part participants.

When these participation numbers were multiplied by the placement rates (continued, temporary, and retained), the calculation resulted in a total of 211 placements:

	Population base	Placement Rate	Placements
• FY 2021-FY 2023 continued	101 x	98% =	99
• FY 2021-FY 2023 temporary	101 x	2% =	2
• Pre-FY 2021 retained	204 x	54% =	110

Total Placements = 99 continued + 2 temporary + 110 retained placements = **211**

The carpool participant survey also was used to estimate the VTR factors and travel distances. That survey estimated a continued carpool VTR factor of 0.64, a temporary VTR factor of 0.62 (with a 50% temporary discount), and a retained VTR factor of 0.56. The one-way travel distance was 22.8 miles for both continued and temporary placements and 24.7 miles for retained placements. Applying the VTR factors and average distances to the numbers of continued, temporary, and retained placements, the calculation estimated a total of **126 vehicle trips reduced** (63 continued, 1 temporary, and 62 retained) and **2,990 VMT reduced** (1,459 from combined continued and temporary placements and 1,531 from retained placements) from 'Pool Rewards carpool component.

'Pool Rewards Vanpool Program

The vanpool program also was open only to commuters who had been driving alone prior to the program. Thus, all 'Pool Rewards vanpool participants were classified as new placements. Multiplier factors for this program were derived from NTD data collected by MWCOG staff on the number of vanpools in the program, the number of riders in each van, and the miles traveled by each van with the full complement of riders (revenue miles).

The 2023 TDM analysis calculated an impact for 13 vans, with 76 total passengers who participated in the program between FY 2021 and FY 2023. Seven of the vanpools started operating in either FY 2021 or FY 2022 but all were still operating in FY 2023. Thus, all the vanpools were defined as continued vanpools in the analysis.

The continued vanpool VTR factor was derived using the average number of riders in continued vanpools (5.9 riders) and assuming vanpool riders rode in the van all their work days and primarily drove to work prior to joining the vanpool.[12] These calculations resulted in a VTR factor of 1.56 daily vehicle trips reduced for continued placements. The revenue miles data per vanpool were used to derive one-way travel distance of 35.0 miles for continued placements.

When these factors were applied to the 76 total vanpool riders, the calculation resulted in 76 continued vanpool placements. Applying the VTR factors and one-way travel distance resulted in 119 daily vehicle trips reduced and 4,165 daily VMT reduced from 'Pool Rewards vanpool component.

Evaluation Methodology and Data Sources – incenTrip Mobile Application

The incenTrip mobile application is one of several incentive programs implemented by Commuter Connections to encourage commuters to use alternative modes. The application provides incentives for using alternative modes and logging alternative mode trips, with greater rewards earned through more frequent use.

Impacts for this Mass Marketing component were estimated using multiplier factors derived from the 2020 Applicant Placement Rate survey. The survey interviewed employed incenTrip registrants and included new incenTrip program-specific questions to examine use of the program and commute mode changes of registered users.[13] Trips made using incenTrip can be for commute and/or non-commute purposes, thus, the Applicant Placement Rate survey module for this program examined frequency of program use for both trip purposes and the impact multiplier factors derived for incenTrip reflects only commute trip impacts.

Slightly more than half (55%) of incenTrip registrants said they also participated in the GRH program. Because that program is calculated individually, the total count of active registrants (3,587) was first discounted to include only those users who did not participate in GRH. About 19% of incenTrip registrants said they had not logged any commute trips through incenTrip. When these non-loggers were removed from the base, the count of incenTrip users included in the impact calculation was 1,307 (3,587 x 45% non-GRH x 81% commute loggers).

Analysis of incenTrip users who had logged trips derived a continued placement rate of 42.9% and a temporary rate of 16.9%, a VTR factor of 0.38 (continued and temporary) and a one-way travel distance of 18.6 miles. Applying the placement rates, VTR factors, and one-way travel distance to the population base resulted in 782 placements, 230 daily vehicle trips reduced and 4,278 daily VMT reduced by incenTrip users.

[12] The analysis assumed that a small share (5%) of commute trips were made by transit prior to shifting to vanpool use.
[13] The 2020 Applicant Placement Rate survey also added question modules to explore use of Flextime Rewards and CarpoolNow users but the samples of respondents for these programs were too small to derive individual calculation multiplier factors.

Evaluation Methodology and Data Sources – Bike to Work Day Event

Impacts for the fifth component of this program element, Bike-to-Work Day (BTWD) Event, were calculated using data obtained from a survey of BTWD participants conducted following the 2022 BTW Day event. Special events are typically short-term. For example, Bike to Work Day is a one-day event. But the influence of the event can be ongoing; its purpose is to introduce commuters to a new travel option, with the goal that some will continue using the new mode after the event ends. Thus, the BTWD survey included questions regarding participants' use of bicycling for commuting before and after the event, and their ongoing level of bicycle commuting.

The impact methodology estimated the trip reduction impacts of new ridership by calculating the number of commuters who started riding to work after the event or increased the days per week they rode to work and the average number of "new" bike days per week. Two time periods were examined: 1) spring through early fall following the event and 2) early winter following the event. From these data the number of new "seasonal" use and "continued winter" use days were calculated for a year. This number was then converted to a daily figure.

The number of vehicle trips reduced by new bicycling was estimated by multiplying the percentage of participants who drove alone or carpooled on non-bike days (44%) by the number of new daily bicycle trips. VMT reductions were estimated by multiplying the vehicle trip reduction by the average one-way commute distance of these participants (7.8 miles). Emissions reduced were calculated as for other program elements.

Evaluation Methodology and Data Sources – Car Free Day Event

The final Mass Marketing component was Car Free Day, an annual event to encourage commuters to leave their cars at home for one day. CFD events were held in the Washington region in the months of September 2020, 2021, and 2022. Commuters who participated in the events made online pledges, indicating the types of transportation they intended to use for that day and the type of transportation they typically would have used for those trips.

Following the 2022 event, Commuter Connections conducted a brief survey of event registrants to examine their use of car-free and car-lite (e.g., carpool and vanpool) travel options during the CFD event and their subsequent continued use of these options for commute travel.

Car Free Day encourages participants to use non-drive alone modes for any type of trip, but the Commuter Connections TDM analysis captures impacts only for commuting travel. Thus, the CFD survey asked participants about the modes they used both for any CFD trip and for CFD trips to and from work. Participants who had used a car-free/car-lite option for a commute trip were asked if the CFD mode was their usual commute mode, and if not, how did they usually get to work on a non-event day. All employed respondents also were asked how many days per week that they used car-free/car-lite options for commuting before CFD and at the time of the survey, several months after the event. Finally, employed respondents were asked the distance from their home to their usual work location.

The survey found that 86% of all respondents had used a car-free or car-lite option for a commute trip on CFD. For 20% of these respondents, the CFD option was a different mode than they usually would have used, and 62% who changed mode would have driven alone or carpooled/vanpooled. Participants had an average commute distance of 12.8 miles one-way. These results were used to calculate the "event day" trip reduction impact.

The survey further indicated that 9% of employed respondents had increased their regular average frequency of car-free/car-lite options, with an average weekly trip reduction of 3.58 trips, equating to a daily trip reduction of 0.72. These factors were applied to the participant population to estimate the on-going CFD impacts. Emissions reduced were calculated as for other TDM program elements.

Mass Marketing Summary of Goals and Impacts

Table 10 presents the results for the Mass Marketing program element, compared to the goals. Individual goals were not established for any of the individual elements that comprised the Mass Marketing components (direct influence, indirect ridematch and GRH influences, 'Pool Rewards, incenTrip, Bike To Work Day, and Car Free Day).

Table 10
Mass Marketing Goals and Estimated Impacts

	MM Goal	Estimated Impacts
Total Mass Marketing		
• Commuter placements	23,168	14,501
• Daily vehicle trips reduced	10,809	3,588
• Daily VMT reduced	181,932	65,820
• Daily tons NOx reduced	0.0850 T	0.0135 T
• Daily tons VOC reduced	0.0250 T	0.0108 T
• Annual tons CO2 reduced	N/A	6,223.6 T

Impacts vs Goals

Participation Benefit (net over or (under) goal):	Commuters: (8,667)
Transportation Benefit (net over or (under) goal):	Vehicle Trips: (7,221) VMT: (116,112)
Emission Benefit (net over or (under) goal):	NOx: (0.0715) tons per day VOC: (0.0142) tons per day

The Mass Marketing program element was well below its goal for all measures. Participation was 37% under the goal and vehicle trip and VMT reductions were 67% and 64%, respectively, below the goals. Details of the calculation for Mass Marketing are presented in Appendix 7.

Goals were not established for any of the individual elements that comprised the Mass Marketing program element (direct influence, indirect referral influences, 'Pool Rewards, incenTrip, BTW Day, and Car Free Day). But the analysis estimated that direct ad influences accounted for 50% of Mass Marketing vehicle trips reduced. 'Pool Rewards, incenTrip, and the Bike To Work and Car Free Day events accounted for about 43% of the total. The remaining 7% of the credit was generated by GRH and Commuter Operations Center referrals.

The overall Mass Marketing impact shortfalls were without doubt due to the pandemic. The direct influence component of MM Mass Marketing experienced a particularly large drop; the vehicle trip reduction and VMT reduction impacts both declined by more than 80%. This was largely because the

impact, which was calculated on the base of "commuters," excluded workers who were teleworking full-time; these workers comprised one-third of the total worker population. Additionally, the 0.44% of workers who reported hearing and being influenced by Commuter Connections advertising was about half the 0.92% reported in 2020. But most other MM components also had lower impacts in 2023 than in 2020, generally due to reduced participation. Interestingly, placement rates, VTR factors, and commute distances for commuters who were participating in other MM programs were not substantially different in 2023 than in 2020.

Section 8 Commuter Operations Center

Background

Since 1974, COG has offered basic commute information and assistance, such as regional ridematching database, to commuters living and/or working in the Washington metropolitan region. Prior to 1997, when Commuter Connections was established, these services were provided by COG's RideFinders program. Because these services were available when the other TDM program elements were developed, the Center was designated as an ongoing program. It is also part of the region's congestion management process.

The function of the Commuter Operations Center is to increase commuters' awareness of alternative modes, through regional and local marketing and outreach programs and to encourage and assist commuters to form ridesharing arrangements. Encouraging commuters who drive alone to shift to alternative modes is a priority for the COC, but the COC also assists commuters who now use alternative modes to continue to do so, by offering ridematching and transit assistance when carpools break up or commuters' travel patterns change and disrupt existing alternative mode arrangements.

Commuter Connections program services include carpool and vanpool matchlists, transit route and schedule information, information on Park & Ride lot locations and HOV lanes, telework information, commute program assistance for employers, GRH, and bicycling route and walking information. Commuters obtain services and information primarily through the Commuter Connections website which features Google translate for non-English speaking individuals, but also can call a toll-free telephone number with English or Spanish options or contact a local partner assistance program for personal assistance from a commuter services representative.

Evaluation Methodology and Data Sources

Over the years it has been in existence, the Commuter Operations Center has enhanced the services it offers to commuters and expanded its marketing of alternative modes to raise public awareness of and interest in alternatives. These efforts were designed to increase the number of commuters placed in alternative modes and generate trip, VMT, and emission reduction benefits for the region. Further, the activities of the COC support the implementation of the other program elements administered by Commuter Connections. Thus, although it pre-dates the development of most Commuter Connections program elements, the COC is included in this evaluation.

Base COC Impacts

The base impacts of the Commuter Operations Center were measured through two surveys, the 2020 Commuter Applicant Placement Survey and the 2021 Retention Rate survey. The 2020 Placement survey, conducted in November 2020, assessed commute travel for commuters who received commute assistance services from Commuter Connections during the 2020 evaluation period. The Retention Rate survey, which was conducted in spring 2021, examined commute travel for commuters who received COC services prior to the 2020 evaluation period.

Placement Survey

The November 2020 Placement Survey polled 282 commuters who received commute assistance services from Commuter Connections between July 1, 2020 and September 30, 2020. The survey asked detailed questions to define travel behavior changes commuters made after they received the commute services. Information collected, included, among other elements:

- Commute patterns: Current mode and previous mode (if commuter made a mode shift), frequency of mode use, travel distance, access mode to rideshare/transit pick-up point, and pool occupancy
- Permanence of mode changes: Whether change was continued (still in effect) or temporary (commuter had reverted to the original mode)
- Motivation: Role of Commuter Connections' assistance in decisions to start or increase alternative mode use

Data from the Placement survey were used to derive placement rates, VTR factors, and travel distance impact calculation multipliers for commuters who received Commuter Connections services during the FY 2021 - FY 2023 evaluation period. Multipliers were estimated for two applicant sub-populations, defined by participants' home and work jurisdictions. The first population included participants who both lived and worked in any of the 15 jurisdictions in the Washington, DC-MD-VA ozone National Ambient Air Quality Standard (NAAQS) nonattainment area (NAA).[14] The second population included participants who worked in the NAA but lived outside it. This distinction was made because applicants who lived outside the NAA traveled a portion of their VMT outside the NAA. These "out of NAA" applicants were discounted to include only the portion of the VMT reduction that occurred within the NAA. Approximately 55% of the total participants lived outside the NAA.

Retention Rate Survey

The 2021 Retention Rate Survey interviewed 1,316 commuters who had participated in Commuter Connections services prior to the start of the FY 2018 – FY 2020 evaluation period (Pre-FY 2018). About 68% of the survey respondents had been registered for GRH and 32% had used only a non-GRH service. Impacts for respondents who participated in GRH are counted in the TDM analysis under the GRH program element. Respondents who used only non-GRH services are counted in the analysis under the Commuter Operations Center.

The objective of the Retention survey was to identify past COC applicants who made a change to an alternative mode after receiving commute assistance (alternative mode placement) and who were still using the alternative mode at the time of the survey (retained in alternative modes). For this purpose, the survey included questions about, among other elements:

- Current commute pattern: Current modes, frequency of mode use, and commute distance
- Previous commute patterns: Modes used prior to receiving Commuter Connections services and frequency of mode use
- Motivation: Importance of Commuter Connections services to continue use of alternative modes

[14] The 15 jurisdictions included in the NAAQS nonattainment area (NAA) are: District of Columbia, Calvert County (MD), Charles County (MD), Frederick County (MD), Montgomery County (MD), Prince George's County (MD), Arlington County (VA), Fairfax County (VA), Loudoun County (VA), Prince William County (VA), City of Alexandria (VA), City of Fairfax (VA), City of Falls Church (VA), City of Manassas (VA), and City of Manassas Park (VA).

Data from the Retention Rate survey were used to derive the placement rate, VTR factor, and travel distance calculation multipliers for past "retained" COC applicants. The survey did not ask respondents about their home location, so it was not possible to calculate separate Within NAA and Outside NAA factors. Because all commuters traveled part of their commute within the NAA, it was reasonable to use an overall placement rate and an overall VTR factor for all respondents, but it was necessary to adjust the overall travel distance to include only the Within NAA portion of VMT. In past placement surveys, the Within NAA distance was approximately 77% of the overall distance; this discount factor was applied to the overall distance from the Retention Rate survey to estimate the Within NAA factor.

Calculation Factors and Impacts

Placement Rate and Placements – The first calculation factor used in the TDM analysis is placement rate, equal to the percentage of COC applicants who made a mode shift to an alternative mode. For the FY 2021 – FY 2023 program participants, placement rates were calculated for Within NAA participants and Outside NAA participants. For each geographic sub-population, two rates were calculated, based on the amount of time the respondent had used the new alternative mode. A "continued" rate was estimated for respondents who continued using the new alternative mode until the placement survey was conducted. A "temporary" rate was estimated for respondents who made a switch but returned to their original mode before the survey.

The placement rate for Pre-FY 21 "retained" applicants was calculated from the Retention Rate survey. Because participants must have continued their use of alternative modes to be counted as retained, all the Pre-FY 2021 placements were counted as continued.

To determine the number of commuters placed in alternative modes, the placement rates were multiplied by the numbers of COC applicants for the corresponding period and location group. A total of 51,018 commuters received services between July 2020 and June 2023. About 42% of the requests were from new applicants or re-applicants. The COC also provided follow-up assistance, with additional match names for existing carpools and vanpools that needed a new or additional rider to maintain or expand existing ridesharing arrangements.

The count of past applicants for the Pre-FY 2021 period, was estimated to be 6,456.[15] This count reflects the combination of the past applicant count from the Retention Rate survey for the period before July 2018, the cutoff date for the Retention Rate survey, plus an estimate for COC users whose last service was between July 2018 and June 2020.

These calculations resulted in a total of **29,679 placements**, with 28,756 (97%) new placements from FY 2021 – FY 2023 applicants and 923 (3%) retained placements from Pre-FY 2021 applicants:

	Population base		Placement Rate		Placements
FY 2021 – FY 2023					
• Within NAA - continued	22,958	x	44.5%	=	10,216
• Within NAA - temporary	22,958	x	11.7%	=	2,686
• Outside NAA - continued	28,060	x	42.9%	=	12,038

[15] The count of FY 2021-FY 2023 current applicants reflected actual travel conditions and COC applicants during the coronavirus pandemic period. The Pre-FY 2021 past participants count, however, reflected travel during a pre-pandemic commuting period. It is likely some past applicants were now teleworking/working remotely full-time rather than commuting based on the 2022 SOC analysis of teleworkers. To account for this likelihood, the past applicant base was adjusted downward; 30% of past applicants were assumed to be no longer commuting and the base used for the calculation was 70% of the original total past applicant count.

	Population base		Placement Rate		Placements
• Outside NAA - temporary	28,060	x	13.6%	=	3,816
Pre-FY 2021					
• Within NAA - continued	2,905	x	14.3%	=	415
• Outside NAA - continued	3,551	x	14.3%	=	508

Total Placements = 28,756 new placements + 923 retained placements = **29,679**

VTR Factors and Vehicle Trips Reduced – These placement figures were then multiplied by VTR factors derived from the Placement survey (FY 2021 – FY 2023) and Retention Rate survey (Pre-FY 2021) to estimate the number of vehicle trips reduced. The VTR factor for each sub-population is as follows:

FY 2021 – FY 2023
- Within NAA - continued 0.23 vehicle trips reduced per placement
- Within NAA - temporary 0.50 vehicle trips reduced per placement
- Outside NAA - continued 0.25 vehicle trips reduced per placement
- Outside NAA - temporary 0.76 vehicle trips reduced per placement

Pre-FY 2021
- Within NAA - continued 0.80 vehicle trips reduced per placement
- Outside NAA - continued 0.80 vehicle trips reduced per placement

The vehicle trip reductions for temporary placements also were discounted to reflect their short duration of 10.4 weeks (20% of a year). The calculation of vehicle trips reduced produced a total of **6,947 vehicle trips reduced**; 6,209 vehicle trips reduced by new (FY 2021 – FY 2023) applicants and 738 from retained (Pre-FY 2021) applicants.

Commute Distance and VMT Reduced – Next, VMT reduction from COC applicants was calculated by multiplying the numbers of vehicle trips reduced by the average trip length for commuters who made a shift to an alternative mode. For the FY 2021 – FY 2023 registrants, the one-way trip distance for the within NAA respondents was 23.1 miles for both continued and temporary mode change applicants. The actual one-way distance for the outside NAA respondents was 49.0 miles, but to discount the distance credited to the outside NAA respondents, their one-way travel distance was set equal to that of the distance for the within NAA respondents. For the Pre-FY 2021 retained registrants, the commute distance was 19.6 miles; this was used for both the Within NAA and Outside NAA groups:

FY 2021 - FY 2023
- Within NAA/Outside NAA - continued 23.1 miles reduced per trip
- Within NAA/Outside NAA - temporary 23.1 miles reduced per trip

Pre-FY 2018
- Within NAA/Outside NAA - continued 19.6 miles reduced per trip

The calculation of VMT reduced produced a total of **157,893 VMT reduced**, with 143,428 VMT reduced by new FY 2021 – FY 2023 applicants and 14,465 VMT reduced by retained (Pre-FY 2021) applicants.

Emissions Reduced – Estimates of reductions in NOx, VOC, and CO2 for the COC were calculated using regional emission factors, as described for the Telework and GRH program elements. Details of the COC calculations are presented in Appendix 8. The overall COC results were adjusted to account for overlap with the Integrated Rideshare Software Upgrades (described below), GRH, and Mass Marketing.

To avoid double counting of impacts, the COC's contributions to these program elements were subtracted from the COC "basic impacts."

Software Upgrades

Included within the Commuter Operations Center program is the Integrated Rideshare Software Upgrades Project. When it began, Integrated Rideshare provided improvements to the quality and delivery of alternative mode information. Commuter Connections added transit, park and ride, telecenter/co-working center, and bicycling information to carpool/vanpool ridematch lists to inform commuters of the range of travel options that were available.

Since 2008, when Commuter Connections introduced its updated web-based TDM system, these additional services have been available on a self-service basis through the online TDM information system. These services represent upgrades to the original ridematching services, so their impacts are captured under the Commuter Operations Center, but are reported separately.[16]

By providing transit and telework information to all commuters who received ridematches, the service is expected to encourage commuters to try transit and park & ride lots, even if they did not have these options in mind when they requested assistance. The Software Upgrade portion of the program element was implemented in October 1998. In the 2008 evaluation, this component was merged into the COC impacts. This arrangement was used also for the 2011, 2014, 2017, and 2020 evaluations, but Software Upgrade impacts are calculated separately.

Impacts of the Software Upgrades was assessed using data from the November 2020 Applicant Placement Survey. This survey assessed changes commuters made after receiving a ridematch or other commute service from Commuter Connections. Respondents were asked if they remember receiving transit and/or Park and Ride, telecenter/co-working locations, and bicycling information along with other ridematching information from the Commuter Operations Center. Respondents who recalled any or all these services were asked follow-up questions to determine if they used the information to make any travel changes. Mode changes that were influenced by use of any of these information services were captured in this COC component.

Placement Rate and Placements – The surveys showed that 6.5% of applicants who lived within the NAA and 7.5% of applicants who lived outside the NAA used the transit, P&R, bicycle, and/or telework information to shift to an alternative mode. About half in each location group said they continued using the alternative mode. To estimate commuter placements, placement rates were multiplied by the commuters who applied to Commuter Connections or received follow-up assistance from Commuter Connections during the evaluation period. These calculations resulted in a total of **3,596 placements**, divided as shown below:

	Population base		Placement Rate		Placements
• Within NAA - continued	22,958	x	2.9%	=	666
• Within NAA - temporary	22,958	x	3.6%	=	826
• Outside NAA - continued	28,060	x	4.1%	=	1,150
• Outside NAA - temporary	28,060	x	3.4%	=	954

[16] Integrated Rideshare originally had two components; Ridematching Software Upgrades, and InfoExpress Kiosks. The InfoExpress Kiosk project was discontinued during the 2005-2008 evaluation period.

VTR Factors and Vehicle Trips Reduced – These placement figures were then multiplied by VTR factors derived from the Placement survey to estimate the number of vehicle trips reduced. The VTR factor for each sub-population is as follows:

- Within NAA - continued 0.23 vehicle trips reduced per placement
- Within NAA - temporary 0.50 vehicle trips reduced per placement
- Outside NAA - continued 0.25 vehicle trips reduced per placement
- Outside NAA - temporary 0.76 vehicle trips reduced per placement

The vehicle trip reductions for temporary placements also were discounted to reflect their short duration of 10.4 weeks (20% of a year). The calculation of vehicle trips reduced produced a total of **669 vehicle trips reduced** by applicants who were assisted or influenced by the Software Upgrades.

Commute Distance and VMT Reduced – VMT reduction was calculated by multiplying the numbers of vehicle trips reduced by the average trip length for commuters who made a shift to an alternative mode:

- Within NAA/Outside NAA - continued 23.1 miles reduced per trip
- Within NAA/Outside NAA - temporary 23.1 miles reduced per trip

As noted in the descriptions for both the GRH program element and the COC, these distances were used for both Within NAA and Outside NAA respondents. The calculation of VMT reduced produced a total of **15,454 VMT reduced**.

Emissions Reduced – Emission reduction was calculated using trip-based and VMT-based regional emission factors. Calculation details for the software upgrade are shown in Appendix 9. To avoid double counting of impacts, the Software Upgrades impacts were subtracted from the COC "basic impacts."

Telework Assistance Outside of Maryland

As noted in Section 4 (Telework Assistance), commuters who received telework assistance from Commuter Connections but who lived and/or worked outside Maryland are not counted in the Telework program element. Instead, their impacts are counted in the COC. The calculation for these impacts follows the method described in Section 4.

Using results from the 2022 State of Commute survey, the number of non-Maryland telecommuters who had direct contact with the Telework program element during the evaluation period were estimated and divided into "home-based" and "non-home-based" groups. These numbers of telecommuters were then multiplied by average VTR factors and one-way travel distances, as identified by the appropriate survey data, to obtain the number of vehicle trips and VMT reduced by their telecommuting.

- VTR factor for non-Maryland-based home-based telecommuters was 0.29 daily trips reduced per telecommuter and the average one-way travel distance was 13.8 miles.
- The VTR factor for non-home-based telecommuters was 0.04 and the net VMT reduced per telework day was 5.8 miles.

These calculations resulted in an estimated **53,303 telecommuters, 15,058 daily vehicle trips reduced, and 207,288 daily VMT reduced** by Commuter Connections-assisted telecommuting. These impacts were added to the COC base impacts.

Commuter Operations Center Summary of Goals and Impacts

Table 11 presents the evaluation results for the COC and the goals established for the Center.

Table 11
Commuter Operations Center Regional Goals and Estimated Impacts

	COC Goal	Estimated Impacts
Commuter Operations Center (basic services)		
• Total commuters (new, re-apply, follow-up)	91,609	51,018
• New applicants during evaluation period	N/A	5,615
• Number of past applicants (Pre-FY 2021)	N/A	6,456
• Daily vehicle trips reduced	24,425	19,048
• Daily VMT reduced	512,637	297,963
• Daily tons NOx reduced	0.2410 T	0.0676 T
• Daily tons VOC reduced	0.1150 T	0.0611 T
• Annual tons CO2 reduced	N/A	29,235.5 T
Impacts vs Goals – Basic COC		
Transportation Benefit (net over or (under) goal):	Vehicle Trips: (5,377) VMT: (214,674) miles	
Emission Benefit (net over or (under) goal):	NOx: (0.1734) tons per day VOC: (0.0539) tons per day	
Software Upgrades (additional to Basic COC)		
• Daily vehicle trips reduced	2,379	669
• Daily VMT reduced	66,442	15,454
• Daily tons NOx reduced	0.0280 T	0.0030 T
• Daily tons VOC reduced	0.0110 T	0.0022 T
• Annual tons CO2 reduced	N/A	1,468.8 T
Impacts vs Goals – Software Upgrades		
Transportation Benefit (net over or (under) goal):	Vehicle Trips: (1,710) VMT: (50,988) miles	
Emission Benefit (net over or (under) goal):	NOx: (0.0250) tons per day VOC: (0.0088) tons per day	

The Basic COC services missed the vehicle trip and VMT reduction goals by 22% and 42% respectively. But the COC impacts are comprised of both impacts from commuter applicants who register with Commuter Connections to receive alternative mode information; and those who receive assistance from Commute Connections for telework and it is useful to provide additional details about the impacts generated by these two groups. The share of COC impacts generated by applicants in 2023 (VT = 3,990,

VMT 90,675) was only about one-third the applicant impacts in 2020 (VT = 9,368, VMT 272,303). This was due to greatly diminished commuting throughout the evaluation period, related to the pandemic.

Conversely, the impacts generated by non-Maryland telework in 2023 (VT = 15,058, VMT = 207,288) were nearly double the telework impacts in 2020 (VT = 6,912, VMT = 102,881). Telework accounted for about 79% of the total COC vehicle trips reduced and 70% of the COC's VMT reduction. The COC Base goals were increased following the FY 2012-14 evaluation to represent the addition of non-Maryland telework credit to the Commuter Operations Center but even the telework increase did not overcome the applicant decline. The Software Upgrades component also missed the goals for vehicle trips and VMT reduced, by 72% and 77%, respectively, also due to the drop in commuter applicants.

Note, however, that it is likely that the COC calculation underrepresents the true impact of both the Software Upgrades and basic COC program. The COC impacts are calculated only on commuters who can be contacted through a follow-up survey to identify travel changes they made after receiving Commuter Connections services. But the Commuter Connections website offers general information on commute options as well as links to Park & Ride lot information and to other resources, which commuters can use without making a formal application to Commuter Connections. Thus, some COC service recipients likely were excluded from the analysis. The extent of the impact undercounting cannot be estimated, but in the 2022 SOC survey, more than 72,000 commuters said they had contacted Commuter Connections or visited the Commuter Connections website in the past year. This greatly exceeds the three-year total of 51,018 commuters who were included in the COC calculation.

The results shown in Table 12 were adjusted to eliminate overlap between the COC and individual program elements. A portion of COC impacts were assigned to Software Upgrades, GRH, and incenTrip, to account for use of the COC and these other services. Finally, the impacts for 2.0% of new COC applicants were assigned to Mass Marketing, to reflect the referred impact of this program element in influencing commuters to contact CC for travel-assistance services.

Table 12
Adjustment of Vehicle Trips and VMT for Overlap between the COC and Program Elements (excluding telework credit for non-Maryland telecommuters)

Evaluation Measure	Basic COC	Mass Marketing	Software Upgrades	GRH	incenTrip	Net Basic COC
VT reduced	6,947	137	669	2,084	67	3,990
VMT reduced	157,893	3,155	15,454	47,368	1,241	90,675
Daily T NOx red.	0.0304	0.0006	0.0030	0.0091	0.0003	0.0174
Daily T VOC red.	0.0216	0.0004	0.0022	0.0065	0.0003	0.0122
Annual T CO2 red.	14,849.3	296.8	1,468.8	4,454.8	163.2	8,465.7

Notes:
- Mass Marketing (referred influence)– new applicants influenced by ads to contact CC, see Section 6
- Software upgrades – see description in this section
- GRH – 72% of new/reapply applicants who shifted to alternative modes registered for GRH = 30% of Base COC credit was assigned to GRH (72% x 42% new/reapply share of total applicants)
- incenTrip – 29% of incenTrip users also registered for COC – see description of overlap in Section 6

Table 13 shows the addition of the net Base COC and telework credit for non-Maryland telecommuters who were assisted by Commuter Connections.

Table 13
Total Commuter Operations Center Credit
(Adjusted Base COC + Non-Maryland Telework)

Evaluation Measure	Net Basic COC	Non-MD Telework	NET COC TOTAL
VT reduced	3,990	15,058	19,048
VMT reduced	90,675	207,288	297,963
Daily T NOx reduced	0.0174	0.0502	0.0676
Daily T VOC reduced	0.0122	0.0489	0.0611
Annual T CO2 reduced	8,465.7.8	20,769.8	29,235.5

Section 9 Summary of TDM Program Element Impacts

The preceding sections of this report documented estimated impacts for four individual TDM program elements and for the Commuter Operations Center. As noted earlier in the report, the four TDM program elements combined fell about 17% short of the collective goal for vehicle trips reduced and 13% short of the goal for VMT reduced. The TDM program elements did not reach the emission goals; the impact for NOx was 58% under the goal and VOC impact was 41% below but these deficits were due in part to reductions in the emission factors. Commuter Connections reset some goals following the 2014 and 2017 TDM analyses but several have been in place since 2017. The emission factors used in the 2023 evaluation were considerably lower than the factors applied in past evaluations, reflecting a cleaner vehicle fleet.

When the COC results are added to the impacts of the four program elements impacts, the combined impact was 18% below the vehicle trip reduction goal and 20% under the goal for VMT reduced. The combined program element–COC program impact fell 61% short of the NOx goal and was 43% below the VOC goal. Again, the change in the emission factors affected the emission results.

Many factors enter into the calculation of impacts, including participation in individual program elements as well as the current and previous commute patterns of program users. Only two program elements met individual goals for participation and travel impacts. Individual sections of this report have discussed factors that affected the achievement of goals for individual program elements. But without question, commute disruption and high use of work from home related to the coronavirus pandemic were significant factors in both the overall impact results and the results for most program elements.

The pandemic began in late March 2020. Thus, the 2020 TDM analysis primarily represented a pre-pandemic period, with only the last three months (April-June 2020) substantially affected. In the early months of the pandemic, workplace and commuting adjustments were anticipated to be temporary. However, as the pandemic continued into 2021 and, to a lesser but still notable extent, into 2022, it became clear that work and commuting patterns remained unsettled. While commute travel has been resuming since late 2021, many employers had not fully returned to pre-pandemic worksite operations even at the end of 2022, thus pandemic-related disruptions should be expected to affect nearly all the FY 2021 – FY 2023 evaluation period.

Impacts of most Commuter Connections programs are based on actual use of the programs and where shortfalls occurred against travel reduction goals, they appear related to lower than expected commuter participation rates, rather than different travel patterns among service users than in the past. The analysis found that the placement rates and VTR factors applied to participation counts in 2023 were not dramatically different than for the 2020 analysis, suggesting the individual impact of Commuter Connections' TDM services among commuters who used them was similar to 2020; what had changed was the number of workers who were still commuting and who needed commute services.

The only program element that met individual goals for participation and travel impacts was Telework–Maryland Assistance. This program benefitted from the expanded use of telework as a pandemic emergency response and the interest of both employers and individual teleworkers in obtaining information that could be helpful in navigating new work from home requirements.

Highlights of the results and comparisons to goals are presented below for the four individual program elements and the COC.

Maryland Telework Assistance

Regional Telework – In 2022, more than 2.1 million regional workers teleworked at least occasionally, representing about 65% of the total regional workforce and 66% of all workers who were not self-employed, working only at home. This number of regional telecommuters represented a doubling of the 2019 count of 1,073,000, and more than seven times the 1996 baseline of 150,900 telecommuters.

Telework in the Washington region had been growing at a steady rate since the later 1990s, but the 2022 growth was an abrupt response to the coronavirus pandemic, which shut down many worksites in late March 2020. In the early months of the pandemic, the extensive use of telework in lieu of commuting was anticipated to be temporary. However, at the time of this report in mid-2023, telework remains a far more common work arrangement than pre-pandemic. Results from the TDM analysis show that Commuter Connections telework services supported some of the telework growth.

The Maryland Telework program element includes two components:

- Regional telecommuters who live and/or work in Maryland who were influenced by Telework services/assistance to begin telecommuting
- Telecommuting employees at Maryland worksites that were assisted by Commuter Connections

Maryland Telework – Overall, about 2.8% of regional telework can be attributed to the efforts of the Telework program element, either directly through information distributed to commuters, through regional advertising to the public-at-large, or through assistance to employers to start a telework program. In the 2022 State of the Commute Survey, Maryland telecommuters accounted for approximately 43% of regional telecommuters and more than 6% of Maryland telecommuters mentioned Commuter Connections or MWCOG as a source of telework information. While the percentage of commuters who requested assistance declined from the 9% estimated in the 2019 SOC survey, it reflects a considerably larger absolute number of teleworkers due to the larger telework base.

The average telework frequency also rose with the pandemic, nearly tripling to 3.37 days per week in 2022 from the 2019 average of 1.21 telework days per week. The combination of high percentage of workers teleworking and high frequency of telework produced a nearly five-fold increase in the percentage of commute trips replaced by telework in 2022, compared with 2019. In 2022, telework accounted for 48% of commute trips, compared with about one in ten trips in 2019.

Clearly, most of the telework increase was due to the pandemic but telework assistance provided by Commuter Connections was a resource that was used by both employers and workers to adjust to the pandemic. Because the telework impact methodology had always assigned credit to the Telework program element only for telework that could be related directly to Commuter Connections' assistance, the methodology was fundamentally still valid for the 2023 TDM analysis, with one adjustment. Impacts for assistance directly to teleworkers were calculated assuming the pre-pandemic telework frequency of 1.21 days per week rather than the 3.37 days per week that was estimated from the 2022 SOC survey.

In this way, the Telework program element received credit for all the teleworkers who were assisted but for only the days they would likely have been teleworking had the pandemic not occurred. Commuter Connections had revised the telework goals following the 2014 TDM analysis to apply the average telework frequency at that time; use of the lower 2019 frequency was consistent with the assumptions in developing the goals. Additionally, in the calculation of impacts for telework assistance to employers that participate in Maryland Telework, only 15% of new telework at these worksites was credited to the Telework program element; most was assumed to be pandemic-related.

Even with this conservative approach, the program element easily met its participation and travel impact goals. The number of Maryland telecommuters estimated for the program element was 85% over the number of telecommuters expected from this element. The element also exceeded the reduction goals for vehicle trips (109%) and VMT (103%).

Note also that this program element includes only outreach and assistance efforts to commuters who live or work in Maryland and to a small number of employers that receive telework assistance from Commuter Connections. Commuter Connections also provides telework information and assistance to commuters in other parts of the Washington metropolitan region. The impacts of these efforts are counted under the Commuter Operations Center.

Guaranteed Ride Home

During the FY 2021 – FY 2023 evaluation period, 3,308 commuters participated in GRH; this represents just 18% of the GRH participant goal. The vehicle trip reduction and VMT impacts also were below these GRH goals, although the retained impact from registrants who participated before the start of the FY 2021-FY 2023 evaluation and who continued to use alternative modes even after leaving the program somewhat offset the shortfall from current registrants. Vehicle trip and VMT impacts were about 32% and 29%, respectively, of the goals, compared with 18% for participation.

COG adjusted the goals for this program after the 2005 evaluation to reflect the fact that a sizeable share of GRH registrants used non-drive alone alternative modes prior to registering. These changes resulted in vehicle trip and VMT goals that more accurately reflected expected trip reduction per new GRH registrant. After peaking in 2008, GRH participation dropped steadily between 2005 and 2020. Past TDM analyses have noted possible reasons, including commuters feeling less concerned about being stranded because they have a greater number of travel options and a decline in regional awareness of the program. But the decline noted between the 2020 analysis and 2023 analysis was dramatic; participation declined from nearly 13,000 participants during FY 2018 – FY 2020 to only 3,308 during FY 2021 – FY 2023.

Applications dropped off abruptly in spring 2020, at the start of the coronavirus pandemic, and remained low throughout the evaluation period. It is likely that many of the commuters who did not renew their GRH registrations were either working from home full-time or most of their workdays. In the 2022 GRH survey, 41% of all past registrants cited working from home as a reason to leave the GRH program.

During FY 2020 and the first half of FY 2021, Commuter Connections also paused much of its GRH advertising, because so many workers were working from home. In the fall of 2021, Commuter Connections sent attempted to reach the nearly 13,000 past GRH members who had not re-registered when their annual registration ended. GRH radio advertising was resumed in the winter/spring of 2022 but it is likely many commuters were still working from home.

Despite the drop in program use, GRH advertising does appear to generate engagement among those who hear the ads. In the 2022 GRH survey, about one-quarter of GRH registrants said they were influenced to apply for GRH after they heard a Mass Marketing GRH advertisement. To recognize this overlapping influence of the two programs, a portion of total GRH impacts were assigned to Mass Marketing. While this boosted the Mass Marketing impact credit, it reduced the GRH impacts reported in this analysis.

Finally, the current GRH participation does not entirely reflect the impact of the GRH program. In 2021, COG conducted a "Retention Rate" survey, which asked commuters who participated in GRH and/or other Commuter Connections services before FY 2019 about their current commute travel. The survey estimated that about 15% of past GRH registrants had made shifts to new alternative modes and were continuing to use these new modes, even though they were no longer in GRH. Thus, the GRH program impacts extend beyond the 3-year evaluation period. The 2023 TDM analysis calculated that these "retained" alternative mode placements accounted for about 39% of the GRH vehicle trip and 35% of the VMT reductions for GRH. Thus, ongoing use of alternative mode by past registrants somewhat mitigates the decline in current participation.

Employer Outreach

In June 2023, the Employer Outreach program counted 2,166 employers with programs that met the Level 3 or 4 definition for a substantial TDM program. These employers represented nearly 513,000 employees. Level 1 and 2 employers were not included in the regional impact calculation because their level of impact would be very small due to the absence of financial incentives or other substantial commute support services.

Employer Outreach exceeded the employer participation goal by 7%. The high count for participation is notable because 573 employers that were included in the 2020 EO analysis were deleted from the count in 2023. This reflects, in part, an ongoing effort by Commuter Connections and local jurisdiction staff to purge the database of employers that had ceased operations, had moved from the region, and/or were no longer actively involved in the Employer Outreach program. These employers represented about 106,400 employees.

The loss of deleted employers was offset by the addition of 745 employers that were new to Employer Outreach. However, even with the higher count of employers, the EO program fell short of the vehicle trip reduction and VMT reduction goals, by 23% and 19%, respectively. This was due to three factors. First, employers that left the EO program typically had offered more substantial services than did the new employers. Many of the employers in the new category offered telework but few other TDM services, so their non-telework impact on commuting behavior would be minimal.

The second and third factors related to how the growth of telework at EO worksites was addressed in the TDM analysis. To ensure the analysis did not overestimate the EO program's role in telework growth, telework vehicle trip reduction impacts for telework that had been offered prior to FY 2021 (continued impacts) were calculated using the 2019 SOC survey average frequency of 1.21 days per week, rather than the 3.37 days per week average estimated in the 2022 SOC survey. Additionally the analysis credited EO with only 10% of new and expanded telework impacts, assigning 90% to "the pandemic." Thus, impacts from new and expanded employers that offered telework as a strategy contributed less to the total EO impact than has typically been the case in past evaluations.

The final reason for the shortfall in vehicle trip and VMT impacts is that the approach used to estimate vehicle trips reduced through use of non-telework TDM strategies, such as transit subsides, was applied

to the base of employee commute days with telework days excluded. Because telework use was much higher in 2023 than in 2020, the base of commute days was lower than in 2020; in essence, commute mode shifts to transit, ridesharing, and bike/walk that were influenced by non-telework strategies would have been relevant on fewer commute days per week than in 2020 and reduced fewer vehicle trips and VMT in a typical week.

Separate impacts also were calculated for the Employer Outreach for Bicycling component of this program element. This component provides regional outreach to encourage employers to implement worksites strategies that encourage employees to use bicycling for commuting. A total of 732 employers offered bicycle strategies in their worksite programs, above the 590-employer goal for this component. The Employer Outreach for Bicycling component met the vehicle trip reduction goal but missed the VMT reduction goal. The growing availability of bicycling strategies at worksites is likely due to a growing willingness of commuters to consider bicycling for commuting as well as the increasing application of bicycle services in new commercial buildings.

Mass Marketing

This program element estimates impacts for seven primary groups of commuters:

1) All commuters in the Commuter Connections service area
2) Commuter Connections rideshare applicants who were influenced by the marketing campaign to request Commuter Connections services
3) GRH applicants who were influenced by the marketing campaign to request Commuter Connections services
4) Commuters who participated in the incenTrip reward and trip tracking mobile application
5) Commuters who participated in the 'Pool Rewards carpool/vanpool incentive program
6) Commuters who participate in the Bike To Work Day event
7) Commuters who participate in Car Free Day

The Mass Marketing program element was well below its goal for all measures. Participation was 37% under the goal and vehicle trip and VMT reductions were 67% and 64%, respectively, below the goals. Goals were not established for any of the individual elements that comprised the Mass Marketing program element (direct influence, indirect referral influences, 'Pool Rewards, incenTrip, BTW Day, and Car Free Day). But the analysis estimated that direct ad influences accounted for 50% of Mass Marketing vehicle trips reduced. 'Pool Rewards, incenTrip, and the Bike-to-Work and Car Free Day events accounted for about 43% of the total. The remaining 7% of the credit was generated by GRH and Commuter Operations Center referrals.

The overall Mass Marketing impact shortfalls were without doubt related to the pandemic. The direct influence component of MM Mass Marketing experienced a particularly large drop; the vehicle trip reduction and VMT reduction impacts both declined by more than 80%. This was largely because the impact, which was calculated on the base of "commuters," excluded workers who were teleworking full-time; these workers comprised one-third of the total worker population in early 2022. Additionally, the 0.44% of workers who reported hearing and being influenced by Commuter Connections advertising was about half the 0.92% reported in 2020.

But most other MM components also had lower impacts in 2023 than in 2020, generally due to reduced participation. Interestingly, placement rates, VTR factors, and commute distances for commuters who were participating in other MM programs were not substantially different in 2023 than in 2020,

suggesting commuters who used the services had travel patterns and commute changes that were similar to those of commuters who used the services in earlier years.

Commuter Operations Center

The Commuter Operations Center is not a formal TDM program element but was included in this evaluation because it supports the success of the four program elements. The COC received more than 51,000 applications between July 2020 and June 2023. About 42% of the requests were from new applicants or re-applicants and 58% represented additional follow-up assistance to existing applicants who needed a new or additional rider to maintain or expand existing ridesharing arrangements. Impacts for telework assistance provided by Commuter Connections to commuters who live and work outside Maryland also are included in the COC impacts.

The Basic COC services missed the vehicle trip and VMT reduction goals by 22% and 42% respectively. But the COC impacts are comprised of both impacts from commute information applicants and those who receive assistance from Commute Connections for telework. The share of COC impacts generated by applicants in 2023 was only about one-third the applicant impacts in 2020, due to greatly diminished commuting throughout the evaluation period, related to the pandemic. The 2023 number of commuter applicants (51,018) was only about two-thirds (67%) the 2020 count (75,651).

Conversely, the impacts generated by non-Maryland telework in 2023 were nearly double the impacts from the telework component in 2020 and telework impacts accounted for about 79% of the total COC vehicle trips reduced and 70% of the COC's VMT reduction. The COC Base goals were increased following the FY 2012-14 evaluation to represent the addition of non-Maryland telework credit to the Commuter Operations Center but even the telework increase did not overcome the applicant decline.

Note, however, that it is likely that the COC calculation underrepresents the true impact of both the COC program. The COC impacts are calculated only on commuters who can be contacted through a follow-up survey to identify travel changes they made after receiving Commuter Connections services. But the Commuter Connections website offers general information on commute options as well as links to Park & Ride lot information and to other resources, which commuters can use without making a formal application to Commuter Connections.

Thus, some COC service recipients likely were excluded from the analysis. The extent of the impact undercounting cannot be estimated, but in the 2022 SOC survey, more than 72,000 commuters said they had contacted Commuter Connections or visited the Commuter Connections website in the past year. This greatly exceeds the three-year total of 51,018 commuters who were included in the COC calculation.

Additionally, the impacts for the COC were adjusted to eliminate overlap between the COC and several individual program elements, with a portion of COC impacts assigned to Software Upgrades, GRH, and incenTrip, to account for use of the COC and these other services. Finally, the impacts for 2.2% of new COC applicants were assigned to Mass Marketing, to reflect the referred impact of this program element in influencing commuters to contact CC for travel-assistance services.

List of Appendices

Appendix 1
Basic Calculation of VTR Factor

The vehicle trip reduction (VTR) factor represents the average number of vehicle trips that a commuter "placed" in an alternative mode would reduce per day. The VTR factor combines the trip reduction results of three possible types of travel changes that new commuter placements might make:

1. Drive alone commuters shifting to an alternative mode
2. Commuters who currently use an alternative mode shifting to another alternative mode (e.g., from carpool to bus, train to bus, vanpool to carpool, etc.)
3. Commuters who currently use an alternative mode increasing their weekly frequency of alternative mode use (e.g., from carpool one time per week to carpool three times per week)

Shown below is a brief example of how the VTR factor would be derived for seven commuters who made the following travel changes:

- Placement 1 – shift from driving alone 5 days per week to a two-person carpool 5 days per week
- Placement 2 – shift from driving alone 5 days per week to transit 5 days per week
- Placement 3 – shift from driving alone 5 days per week to telework 2 days per week and driving alone 3 days per week
- Placement 4 – shift from driving alone 5 days per week to two-person carpool 2 days per week and driving alone 3 days per week
- Placement 5 – shift from a two-person carpool 5 days per week to transit 5 days per week
- Placement 6 – shift from transit 5 days per week to a two-person carpool 5 days per week
- Placement 7 – increase carpool frequency from 1 day per week to 3 days per week, driving alone the other 2 days

The VTR factor is derived by determining the number of vehicle trips all placements would reduce together and dividing that total by the number of placements. The calculation assumes that a commuter makes two trips a day, one from home to work and a second from work to home. Thus, a commuter who drives alone would make 2 vehicle trips each day. A commuter who carpools would make ½ vehicle trip to work and ½ trip back home, for a total of 1 vehicle trip per day. A commuter who uses bus, train, bike, or walk is assumed to make 0 vehicle trips. A commuter who teleworks also makes 0 vehicle trips for telework days.

Shown on the next page are the travel modes and the numbers of vehicle trips each of the seven commuters described above would make for each day of the week before the shift to an alternative mode and after the shift. The third column shows the net vehicle trips (number of trips after the shift minus number of trips before the shift). The final column shows the total weekly trips reduced. Note that commuter #6 increases weekly commute trips, because he shifts from a higher occupancy alternative mode (transit) to a lower occupancy alternative mode (carpool).

Appendix 1, continued

Sample VTR Calculation
Travel Modes Before and After Shifts to Alternative Modes
By Commuter and by Day of the Week

	Vehicle Trips Before Shift					Vehicle Trips After Shift					Vehicle Trips Net Trips					Weekly
	M	**T**	**W**	**T**	**F**	**M**	**T**	**W**	**T**	**F**	**M**	**T**	**W**	**T**	**F**	**Change**
Placement 1	D	D	D	D	D	C	C	C	C	C						
DA to 2p CP	2	2	2	2	2	1	1	1	1	1	-1	-1	-1	-1	-1	-5 trips
Placement 2	D	D	D	D	D	T	T	T	T	T						
DA to TR	2	2	2	2	2	0	0	0	0	0	-2	-2	-2	-2	-2	-10 trips
Placement 3	D	D	D	D	D	D	D	C	C	C						
DA to TC/DA (part-time)	2	2	2	2	2	2	2	2	0	0	0	0	0	-2	-2	-4 trips
Placement 4	D	D	D	D	D	D	D	C	C	C						
DA to CP/DA (part-time)	2	2	2	2	2	2	2	2	1	1	0	0	0	-1	-1	-2 trips
Placement 5	C	C	C	C	C	T	T	T	T	T						
2p CP to TR	1	1	1	1	1	0	0	0	0	0	-1	-1	-1	-1	-1	-5 trips
Placement 6	T	T	T	T	T	C	C	C	C	C						
TR to 2p CP	0	0	0	0	0	1	1	1	1	1	+1	+1	+1	+1	+1	+5 trips
Placement 7	D	D	D	D	C	D	D	C	C	C						
DA/CP to CP (part-time)	2	2	2	2	1	2	2	1	1	1	0	0	-1	-1	0	-2 trips
Total weekly trips	11	11	11	11	10	8	8	7	4	4	-3	-3	-4	-7	-6	-23 trips

Total placements	= 7 placements (travel for each shown above)
Total trips reduced per week	= 23 trips per week (all placements together)
Total trips per day (all placements together)	= 23 trips per week / 5 days per week
	= 4.6 trips per day
Average trips reduced per placement	**= 4.6 trips per day / 7 placements**
	= 0.66 trips per placement

The seven commuter placements would reduce a total of 4.6 trips during a single day, thus the average number of trips reduced per day by each of the seven placements would be 0.66. This is the VTR factor.

Appendix 2
2008 Adjustment to COMMUTER Model Coefficients and 2021 Review of Model for FY 2021 – FY 2023 Analysis

Impacts for the Employer Outreach program element are calculated using the EPA COMMUTER model (v 2.0). Prior to the 2008 analysis, the default cost and time coefficients for the Washington DC region were used in model runs. Analysis performed by the LDA Consulting team for COG in 2007 suggested the COMMUTER model overestimated the likely impacts of employers' strategies related to financial incentives. Thus, the team examined possible adjustment to the COMMUTER model to give more conservative results for the 2008 TDM analysis.

The results of the analysis suggested the most acceptable option was to reduce the cost coefficient to a level that could be expected to produce a vehicle trip reduction (VTR) change that approximated employee survey results of employers for which before commuter programs were implemented and after implementation. Because "with program" employee survey data were not available for the MWCOG region, the team used data from the Seattle, WA metropolitan region and determined the Seattle cost coefficient that would have predicted the result found in the Seattle survey data. The team then applied a proportional reduction to the current MWCOG cost coefficient.

The team performed a coefficient sensitivity analysis to estimate the VTR result at various cost coefficient levels. Two sensitivity cases were run, to test two different employer situations. The first included employers that had maintained or expanded the services in their commute programs, regardless of their program level (Level 1-4). The second case included employers that would have been classified as Level 3 or Level 4 in the TDM analysis, regardless of the changes they had made in their program. This case was run because it was consistent with the TDM analysis methodology.

Table 1 below shows the results for the Level 3-4 employer case, which was deemed more appropriate for this analysis.

Table 1 - COMMUTER model Vehicle Trip Rate (VTR) change prediction by travel cost coefficient - Level 3 and 4 Employers (Sample size 609)

Travel Cost Coefficient	Survey VTR Change	COMMUTER VTR Change
-0.0009	-2.32	-1.89
-0.0013	-2.32	-2.19
-0.0015	-2.32	**-2.35**
-0.0019	-2.32	-2.66
-0.0024*	**-2.32**	-3.06
-0.0029	-2.32	-3.46
-0.0031	-2.32	-3.62
-0.0034	-2.32	-3.86
-0.0039	-2.32	-4.26
-0.0043**	-2.32	-4.58
-0.0047	-2.32	-4.9
-0.0049	-2.32	-5.06

Coefficient -0.0024 vs -.0015,
Difference of 0.0009
VTR change difference 0.74

VTR difference 0.74
Coefficient difference of 0.009
-0.0043 vs -0.0034

*Coefficient for Seattle **Coefficient for MWCOG region

Appendix 2, continued

As shown, the VTR reduction estimated from the Seattle survey for these employers was -2.32. The COMMUTER model, using the Seattle cost coefficient of -0.0024 would have predicted a VTR result of -3.06, or a difference of about 0.74. To obtain a result of -2.32, the cost coefficient would have to have been -0.0015, or a reduction of 0.0009.

When the sensitivity results were plotted with coefficient on one axis and the VTR change on the other, it was clear that the change in VTR was directly proportional to the change in coefficient. Thus, it was reasonable to apply the same 0.74 difference from the Seattle VTR results to the MWCOG predicted result to estimate the coefficient that would produce a proportionately accurate result in the MWCOG region.

The cost coefficient used with the COMMUTER model in the 2002-2005 TDM analysis was -0.0043. Referring again to Table, 1, a coefficient of -0.0043 would predict a VTR change of -4.58. Applying the 0.74 difference in the VTR change result from the Seattle case to the MWCOG coefficient would result in a new VTR change of -3.84. This number does not match the -2.32 VTR change result for the Seattle data, nor is it reasonable to expect that it would, since the Seattle area survey results reflect Seattle area conditions. It is not unreasonable to assume that the MWCOG area could have a higher VTR change when similar commuter program conditions are in place.

To obtain this -3.84 VTR value, the coefficient for MWCOG would have to be -0.0034. The VTR result of -3.84 would represent about a 16% reduction in impact compared to that produced using the -0.0043 cost coefficient. With these changes, the old (2005) and new (2008) coefficients used in the COMMUTER Model were as follows. No changes were made to the time coefficients. The 2008 coefficients also were used in the 2011 analysis.

	2008 Coefficients	2005 Coefficients
IVTT- In-vehicle travel time - all modes (minutes)	-0.0300	-0.0300
OVTT - Transit walk time (minutes)	-0.0750	-0.0750
OVTT - Transit wait time (minutes)	-0.0750	-0.0750
Cost - Auto parking (cents)	-0.0034	-0.0043
Cost - Transit fare (cents)	-0.0034	-0.0043

Consistency of the COMMUTER Model with MWCOG Regional Model – During 2010-2012, MWCOG developed a new regional travel model used for regional transportation planning and forecasting. To ensure that the COMMUTER Model was consistent with the new regional model, MWCOG modeling staff reviewed the COMMUTER Model cost and time coefficients used in the 2011 evaluation. They concluded that no further adjustments were needed for the 2014 or 2017 TDM analyses to be consistent with the new regional model.

MWCOG continues to use and update this regional model as the model evolves. In 2020 and again in 2022, the research team reviewed regional model guidance documents prepared by MWCOG to determine if any model updates might indicate a needed change in the COMMUTER model coefficients to remain compatible with the regional approach. The review identified numerous model modifications, but none that would affect the validity of the current coefficients for the COMMUTER Model. Most changes were affected the efficiency and speed of model operation, rather than the model results.

Appendix 2, continued

The few changes that altered the model results primarily adjusted assumptions related to bike and walk access to transit in suburban areas. As these changes were not cost related, the research team concluded that the coefficients used for the EO analysis in 2020 could be carried over to the 2023 evaluation.

Review of Other Possible Models for Employer Outreach Analysis – In 2020 the research team examined several other models to determine if any other options would be as reliable and efficient as the COMMUTER model for the Employer Outreach analysis. This review found that none of the alternative models offered both the capability to analyze the wide range of TDM strategy combinations that were implemented by EO employers as well as the capability to analyze efficiently impacts for individual employers. The research team previously developed a technique to run the COMMUTER model for large numbers of individual employers in "batch" mode, allowing an independent impact analysis for each employer, in a highly efficient process. Without this capability, it would be cumbersome to analyze the large number of employers in the EO analysis. Thus, the project team used the COMMUTER Model for the FY 2018 – FY 2020 EO calculation, with the revised coefficients referenced above. The team conducted a similar review in 2022, finding the same result. Thus, the COMMUTER model was used also for the FY 2021 – FY 2023 EO calculation.

Appendix 3
Assignment of Telework Impacts in Commuter Connections TDM Analysis

The triennial TDM analysis includes assessment of telework impacts that have been generated by telework-supportive activities of Commuter Connections staff and/or local jurisdiction partners. Some services are directed to individual workers in the region to increase their awareness of telework options. Others are directed to employers to encourage and assist establishment of worksite telework arrangements and policies.

Because the telework services are implemented under several Commuter Connections TDM Program Elements and for both commuters and employers, the TDM analysis calculates individual telework impacts for each element, correcting for double-counting when impacts would otherwise be counted in more than one category. The impacts are calculated separately for the commuter and employer target telework populations and, as shown in Figure 3-1, impacts are assigned to different TDM Program Elements depending on their location (District of Columbia, Maryland, Virginia) and the telework assistance services they received. Note that the calculated impacts do not include all telework in the region; only impacts that can be tied to a service provided by Commuter Connections or a Commuter Connections partner organization:

Commuters:

The left side of Figure 3-1 shows assignment of impacts for commuters to one of three groups:

- Maryland Telework Program Element
- Commuter Operations Center
- TW impacts not counted

1 – Was commuter assisted by CC – The first step is to determine if a commuter was assisted or influenced by a CC service to start or increase teleworking. The State of the Commute survey includes a question asking teleworkers the information sources/resources they used to start teleworking. They also are asked a direct question to determine if they received TW information/assistance from MWCOG or Commuter Connections.

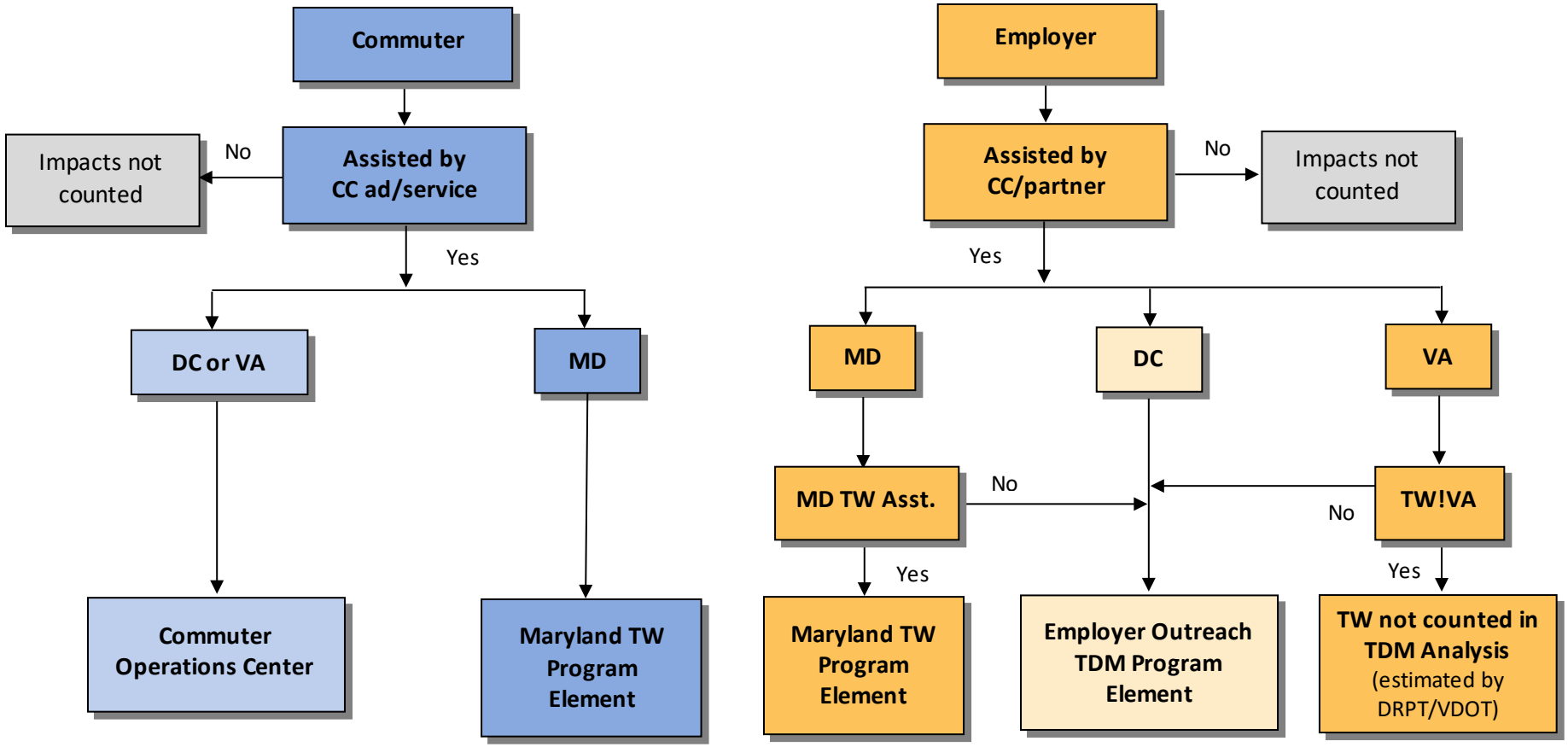
- If they did report MWCOG/CC as a source/resource, their impacts will be credited to MWCOG/Commuter Connections and they move to step 2.
- If they did not report MWCOG/Commuter Connections as a source/resource, their impacts are not credited to MWCOG/CC. They are, however, part of regional telework.

2 – Where does commuter live and work – Assisted commuters are then separated into two categories, by the residence and work state(s).

Live and/or work in Maryland – Impacts of assisted commuters who live AND/OR work in Maryland are assigned to the Telework TDM Program Element. Their vehicle trip and VMT reduction impacts are calculated from SOC data on their frequency of telework (days/week), modes used on non-TW days, and travel distance from home to non-TW work location.

Live and work outside Maryland – Impacts of assisted commuters who live AND work outside Maryland (e.g., DC, Virginia, or other state) are assigned to the Commuter Operations Center Program Element. Their vehicle trip and VMT reduction impacts are calculated from SOC data on their frequency of telework (days/week), modes used on non-TW days, and travel distance from home to non-TW work location.

Figure 3-1
Assignment of Telework Impact to TDM Program Elements by Target Market, Location, and Services Received



Appendix 3, continued

Employers:

The right side of Figure 3-1 shows assignment of telework impacts for employers. Impacts are assigned to one of three groups:

- TW impacts not counted
- Telework TDM Program Element
- Employer Outreach

1 – Was employer assisted by Commuter Connections/partner program – Employer can receive telework assistance from several Commuter Connections-related sources:

- **Maryland Telework** – Employer is in Maryland and is listed in MWCOG/CC assistance database (i.e., received assistance from MWCOG/Commuter Connections website, workshop, or other MWCOG/Commuter Connections resource). *Impacts are calculated and assigned in step 2.*
- **Telework!VA** – Employer is in Virginia and received assistance through VDRPT's TW!VA program. *TW!VA is not part of Commuter Connections TDM Program; telework impacts are calculated by Virginia Department of Rail and Public Transportation and/or Virginia Department of Transportation and reported internally. They are not included in the Commuter Connections TDM Analysis. However, impacts from non-telework services offered by these employers will be assigned to Employer Outreach; only the telework impacts will be excluded.*
- **Employer Outreach** – Employer is a client of one of the Commuter Connections local jurisdiction partner programs and the ACT! Database reported telework for the employer. *Impacts are calculated and assigned in step 2.*
- **No reported assistance** – Employer did not receive MD TW or TW!VA assistance and TW is not reported in the ACT! database. *Impacts not calculated.*

2 – Which assistance program was used – Assisted employers are separated into two categories, by the program used.

- **Maryland Telework assigned to Telework Program Element** – Impacts of assisted employers who received Maryland TW assistance are assigned to the Telework Program Element. These employers are surveyed by Commuter Connections in the Telework Assisted Employer survey to determine the number/percentage of employees who are teleworking. The telework impact is calculated as any increase in number of employees teleworking. Trips/VMT reduced are estimated by applying average TW frequency, drive-alone/carpool/vanpool mode use on non-telework days, and average commute distance from the SOC survey to the number of new telework employees at assisted worksites.
- **Local Jurisdiction Partner Telework Assistance Assigned to Employer Outreach TDM Program Element** – Telework impacts of assisted employers that did not participate in either MD TW or TW!VA are assigned to the Employer Outreach TDM Program Element. Impacts of Employer Outreach assistance, both for telework and non-telework are estimated using the EPA COMMUTER model. The model estimates a final "with services" mode split that would be likely when a defined set of TDM services are offered to employees at the worksite with a starting "without services" mode split. The model estimates telework impacts from the percentage of employees who are reported to be teleworking and the mode split of employees on non-telework days.

Appendix 3, continued

3 – Adjustment to correct for overlap between Employer Outreach and Maryland TW – The final step in the calculation of assisted employer telework impacts is to check for overlap between Employer Outreach and the Maryland TW program. The names and locations of MD TW assisted worksites are compared against the employers/worksites reporting telework in the Employer Outreach Act! Database. If a MD TW worksite is in the Act! Database with telework reported, the telework portion of their EO impact is deducted from the total Employer Outreach impact so that the telework impacts are counted only once, in the Maryland Telework Program Element. Impacts of other (non-telework) TDM services that the employer/worksite offers will continue to be included in the Employer Outreach calculation.

Appendix 4
Calculation of Maryland Telework Assistance Impacts

2 impact components
- CC Assisted Telework – Maryland
- CC Assisted Telework – Non-Maryland

CC Assisted Telework – Maryland and Non-Maryland

Populations of Interest

All regional telecommuters	2,136,576	(from SOC survey)
Teleworkers with MD home or work	925,137	43.3% (from SOC survey)
Teleworkers not in MD	1,211,439	56.7% (from SOC survey)
Employees at TW assisted worksites (MD)	28,202	(from TW assistance survey/EO ACT! database)

Commuter Connections TW Placement Rates

Directly assisted TW

• Within Maryland	6.3%	(% of TC assisted by CC, from SOC survey)
• Not in Maryland	4.4%	(% of TC assisted by CC, from SOC survey)

TW at assisted worksites (MD only)

• Within Maryland	2.4%	(% of new TC at sites, from TW assistance survey)
• Not in Maryland	0.0%	Program not in effect outside of Maryland

TW Placements (Mixed home and Non-home based)

Maryland (credited to Telework Program Element)

• Directly assisted telecommuters	58,284	(regional TC x directly assisted placement rate)
• Telecommuters at TW assisted sites	677	(employees at assisted sites x assisted site placement rate)
Total assisted telecommuters - MD	**58,961**	

Not Maryland (to be credited to COC)

• Directly assisted telecommuters	53,303	(regional TC x directly assisted placement rate)
• Telecommuters at TW assisted sites	0	(employees at assisted sites x assisted site placement rate)
Total assisted telecommuters – Not MD	**53,303**	

Placements by Location (home-based and non-home-based)

• % Home-based telecommuters	97%	(from SOC survey)
• % Non-home (NH)-based telecommuters	3%	(from SOC survey)

Maryland (credited to Telework Program Element)

• Home-based telecommuters	57,192	(total assisted TW x % Home-based TW)
• NH-based telecommuters	1,769	(total assisted TW x % NH-based TW)

Not Maryland (credited to COC)

• Home-based telecommuters	51,704	(total assisted TW x % Home-based TW)
• NH-based telecommuters	1,599	(total assisted TW x % NH-based TW)

Appendix 4, continued

Daily Vehicle Trips Reduced

VTR Factors

- Home-based factor – MD 0.43 (from SOC survey)
- NH-based factor – MD 0.05 (from SOC survey)
- Home-based factor – Not MD 0.29 (from SOC survey)
- NH-based factor – Not-MD 0.04 (from SOC survey)

Maryland (credited to Telework Program element)

- Home-based VT reduced 24,593 (HB TW x HB VTR factor)
- NH-based VT reduced 88 (NH-based TW x NH VTR factor)

Daily Vehicle Trips Reduced - MD	**24,681**

Not Maryland (credited to COC)

- Home-based VT reduced 14,994 (HB TW x HB VTR factor)
- NH-based VT reduced 64 (NH-based TW x NH VTR factor)

Daily Vehicle Trips Reduced – Not MD	**15,058**

Daily VMT Reduced

Ave one-way trip distance (mi) to main workplace

- Home-based – MD 19.9 (SOC survey)
- Home-based – Not MD 13.8 (SOC survey)

Ave one-way trip distance (mi) for non-home-based TW (MD and Not-MD)

- Non-home based – to main workplace 18.7 (SOC survey)
- Non-home based – to TW location 12.9 (SOC survey)
- Non-home based – net VMT reduced 5.8 (SOC survey)

VMT reductions on TW days

Maryland (credited to Telework Program Element)

- Home-based VMT reduced 489,401 (HB VT reduced x average OW miles to main workplace)
- NH-based VMT reduced 510 (NHB VT reduced x net OW miles reduced per trip)

Daily VMT Reduced - MD	**489,911**

Not Maryland (credited to COC)

- Home-based VMT reduced 206,917 (HB VT reduced x average OW miles to main workplace)
- NH-based VMT reduced 371 (NHB VT reduced x net OW miles reduced per trip)

Daily VMT Reduced – Not MD	**207,288**

Appendix 4, continued

Maryland (credited to Telework Program Element)

Emissions Reduced – NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	24,681	0.9596			23,684	0.0261
• From Running			489,911	0.1501	73,536	0.0811
Total NOx reduced (tons)					**Daily**	**0.1072**

VOC	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	24,681	2.1585			53,274	0.0587
• From Running			489,911	0.0575	28,170	0.0311
Total VOC reduced (tons)					**Daily**	**0.0898**

CO2	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	24,681	208.68			5,150,431	5.677
• From Running			489,911	348.43	170,699,690	188.164
Total CO2 reduced (tons)					**Daily**	**193.841**
					Annual	**48,460.3**

Non-Maryland (credited to COC)

Emissions Reduced – NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	15,058	0.9596			14,450	0.0159
• From Running			207,288	0.1501	31,114	0.0343
Total NOx reduced (tons)					**Daily**	**0.0502**

VOC	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	15,058	2.1585			32,503	0.0358
• From Running			207,288	0.0575	11,919	0.0131
Total VOC reduced (tons)					**Daily**	**0.0489**

CO2	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	15,058	208.68			3,142,303	3.464
• From Running			207,288	348.43	72,225,358	79.615
Total CO2 reduced (tons)					**Daily**	**83.079**
					Annual	**20,769.8**

Appendix 5
Calculation of Guaranteed Ride Home Impacts

Populations of Interest

FY 2021-23 Registrant Base (New credit)

• New GRH registrants (FY 2028-23)	1,568	(GRH database)
• Re-registrants from FY 2021	1,740	(Commuter Connections archive database)
• One-time exceptions (FY 2021-23)	0	(GRH database)
New FY 2021-23 GRH base	**3,308**	

Pre-FY 2018 Registrant Base (Retained credit)

• GRH registrants Pre-FY 2021	29,340	(COC GRH/Online databases)
• Valid contact percentage	68%	(Retention rate survey)
• Est percentage NOT full-time TW	70%	(Retention rate survey)
Retained Pre-FY 2021 GRH base	**13,966**	

Distribution of In/Out NAA

FY 2021-23 Registrant Base (New)		
Within NAA	63%	2,084
Outside NAA	37%	1,224
Pre-FY 2021 Registrant Base (Retained)		
Within NAA	63%	8,799
Outside NAA	37%	5,167

GRH Placement Rates and Placements (continued only) (NAA base x NAA placement rate)

FY 2021-23 Registrants (New)		
• Within NAA rate	40.9%	852
• Outside NAA rate	44.1%	540
Pre-FY 2021 Registrants (Retained)		
• Within NAA rate	14.7%	1,293
• Outside NAA rate	14.7%	760
Total Placements[17]		**3,445**

VTR Factors and Daily Vehicle Trips Reduced (continued only) (NAA placement x NAA VTR factor)

FY 2021-23 Registrants (New)		
• Within NAA VTR factor	0.90	767
• Outside NAA VTR factor	0.98	529
Pre-FY 2021 Registrants (Retained)		
• Within NAA VTR factor	0.40	517
• Outside NAA VTR factor	0.40	304
Total Daily Vehicle Trips Reduced		**2,117**

[17] Note that the total placements for purpose of VT and VMT calculations includes both FY 2021-FY 2023 registrants and past registrants from Pre-FY 2021. But only FY 2021-FY 2023 registrants are included in the participation count for comparison with the GRH goal, because the goal is set as number of registrants who were active in the program during the evaluation period.

Appendix 5, continued

Commute Distance and Daily VMT Reduced (NAA VT reduced x NAA distance)

FY 2021-23 Registrants (New)			
• Within NAA distance	27.6	21,169	
• Outside NAA distance	27.6	14,600	(discount actual 50.0 miles from GRH survey)
Pre-FY 2021 Registrants (Retained)			
• Within NAA distance	23.5	12,150	
• Outside NAA distance	23.5	7,144	
Total Daily VMT Reduced		**55,063**	

Trip and VMT Adjustment for SOV Access to HOV Modes (reduce VT and VMT for AQ analysis)

Inside NAA

• SOV access percentage	80%	(GRH survey)
• SOV access distance (mi)	5.8	(GRH survey)

Outside NAA (Adjustments are not applicable, because all access VT and VMT occur outside NAA)

Adjusted VT Reduction – net of VMT access

• Total VT reduced	2,117	
• Within NAA access VT (deduct)	- 1,027	(Total VT reduction within NAA x SOV access %)
• Outside NAA access VT	0	No deduction (access trips are outside NAA)
Total VT for AQ analysis	**1,090**	

Adjusted VMT Reduction – net of VMT access

• Total VMT reduced	55,063	
• Within NAA access VMT (deduct)	- 5,957	(SOV Access VT within NAA x SOV access distance)
• Outside NAA access VMT	0	No deduction (access VMT are outside NAA)
Total VMT for AQ analysis	**49,106**	

Emissions Reduced – NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	1,090	0.9596			1,046	0.0012
• From Running			49,106	0.1501	7,371	0.0081
Total NOx reduced (tons)					**Daily**	**0.0093**

VOC	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	1,090	2.1585			2,353	0.0026
• From Running			49,106	0.0575	2,824	0.0031
Total VOC reduced (tons)					**Daily**	**0.0057**

CO2	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	1,090	208.68			227,461	0.251
• From Running			49,106	348.43	17,110,004	18.861
Total CO2 reduced (tons)					**Daily**	**19.112**
					Annual	**4,778.0**

Appendix 5, continued

Correction for Overlap with Mass Marketing

The GRH results were adjusted to eliminate double counting between GRH and Mass Marketing for new GRH applicants. About **8%** of the FY 2021 – FY 2023 GRH impacts were assigned to Mass Marketing to recognize that 26% of new GRH applicants were influenced to apply for GRH after hearing a Mass Marketing advertisement. These new applicants accounted for 47% of the total GRH applicants (Reapply + New) during FY 2021 – FY 2023. Impacts generated through Retained GRH users (35% of total GRH impacts) were excluded from the base. This calculation resulted in 8% of the GRH credit being assigned to Mass Marketing (47% x 26% new apps x 65% non-retained impacts).

Total GRH apps FYs 21, 22, 23	3,308	
New GRH apps FY 21, 22, 22	1,568	47%
Estimated MM share of new GRH	26%	
FY 2021-23 VMT as % of total VMT	65%	(Exclude Retained credit from discount)
Estimated MM share of GRH impact	**8%**	

Net GRH = GRH Base Total – Mass Marketing credit

	GRH Base Total	GRH Excl Retained	Mass Mkt Credit*	Net GRH Credit*
Placements	3,445	1,392	111	3,334
Vehicle Trips reduced	2,117	1,296	104	2,013
VMT reduced (mi)	55,063	35,769	2,862	52,201
Emissions Reduced				
NOx (daily tons)	0.0093	0.0060	0.0005	0.0088
VOC (daily tons)	0.0057	0.0037	0.0003	0.0054
CO2 (annual tons)	4,778.0	3,105.7	248.5	4,529.5

* Mass Marketing Credit = 8% of (GRH Base Total – GRH Excluding Retained Credit)
Net GRH Credit = GRH Base Total – Mass Marketing Credit

Appendix 6
Calculation of Employer Outreach Impacts

Populations of Interest

Level 3 or 4 sites (data from ACT! database)

	Employers	Employees
• Programs unchanged since 2020	989	264,819
• Expanded non-telework programs in 2023	54	21,562
• Expanded telework programs in 2023	378	116,688
• New programs in 2023	745	109,876
• Deleted programs since 2020	573	106,406

Average Vehicle Occupancy (AVO)

Starting AVO from employee survey data, Final AVO from COMMUTER model

	Starting AVO	Ending AVO
• Programs unchanged since 2020	1.2049	1.3116
• Expanded non-TW programs – continued base	1.1465	1.1976
• Expanded TW programs – continued base	1.2685	1.4336
• Expanded non-TW programs – new impacts	1.1976	1.2428
• Expanded TW programs – new impacts	1.4336	1.4540
• New programs	1.1535	1.1998
• Deleted programs (Ending AVO lower than Starting)	1.4682	1.3462

Daily person trips

Total employees x 2 one-way trips per day; Starting (pre-program) and ending (with-program)

	Starting	Ending
• Programs unchanged since 2020	529,638	529,638
• Expanded non-TW programs (base and new)	43,124	43,124
• Expanded TW programs (base and new)	233,376	233,376
• New programs	219,752	219,752
• Deleted programs	212,812	212,812

Daily vehicle trips

Total employees / starting AVO); Starting (pre-program) and ending (with-program)

	Starting	Ending	Difference
• Programs unchanged since 2020	439,570	403,811	35,759
• Expanded non-TW programs – continued base	37,614	36,009	1,605
• Expanded TW programs – continued base	183,978	162,790	21,188
• Expanded non-TW programs – new impact	36,009	34,699	1,310
• Expanded TW programs – new impact	162,790	160,506	2,284
• New programs	190,509	183,157	7,352
• Deleted programs (Ending VT higher than Starting)	144,948	158,083	(13,135)

Total Daily Vehicle Trips Reduced

• Continued impacts from 2020	58,552
• New/expanded impacts	10,946
Net 2023 reduction	**69,498**

Appendix 6, continued

Daily VMT reduced

Results produced by COMMUTER model, assuming travel distance by mode from SOC survey

• Programs unchanged since 2020	639,298
• Expanded non-TW programs – continued base	29,154
• Expanded TW programs – continued base	380,390
• Expanded non-TW programs – new impact	23,572
• Expanded TW programs – new impact	42,306
• New programs	132,760
• Deleted programs	(237,705)

Total Daily VMT Reduced

• Continued impacts from 2020	1,048,842
• New/expanded impacts	198,638
Net 2020 reduction	**1,247,480**

Trip and VMT Adjustment for SOV Access to HOV Modes (reduce VT and VMT for AQ analysis)

• Non-SOV access percentage	78%	(from 2022 SOC survey)
• SOV access percentage	22%	(from 2022 SOC survey)
• SOV access distance (mi)	2.6	(from 2022 SOC survey)

VT Reduction without SOV access – used as base for AQ analysis

(Total VT reduced x non-SOV access %)

• Continued impacts from 2020	45,671
• New/expanded impacts	8,538

VMT Reduction without SOV access

(Total VMT reduced – (Total daily VT reduced x SOV % x SOV access trip distance))

• Continued impacts from 2020	1,015,351
• New/expanded impacts	192,377

Emissions Reduced – Continued from 2020 - NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	45,671	0.9596			43,826	0.0483
• From Running			1,015,351	0.1501	152,404	0.1680
Total NOx reduced (tons)					**Daily**	**0.2163**

VOC	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	45,671	2.1585			98,581	0.1087
• From Running			1,015,351	0.0575	58,383	0.0644
Total VOC reduced (tons)					**Daily**	**0.1731**

Appendix 6, continued

Emissions Reduced – Continued from 2020 – NOx, VOC, CO2 (continued)

CO2	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	45,671	208.68			9,530,624	10.506
• From Running			1,015,351	348.43	353,778,749	389.974
Total CO2 reduced (tons)					**Daily**	**400.480**
					Annual	**100,120.0**

Emissions Reduced – New/Expanded – NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	8,538	0.9596			8,193	0.0090
• From Running			192,377	0.1501	28,876	0.0318
Total NOx reduced (tons)					**Daily**	**0.0408**

VOC	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	8,538	2.1585			18,429	0.0203
• From Running			192,377	0.0575	11,062	0.0122
Total VOC reduced (tons)					**Daily**	**0.0325**

CO2	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	8,538	208.68			1,781,710	1.964
• From Running			192,377	348.43	67,029,918	73.888
Total CO2 reduced (tons)					**Daily**	**75.852**
					Annual	**18,963.0**

Distribution of Employer Outreach Impacts to EO Base and EO for Bicycling

	Total EO	EO w/o bike	EO-bike
Vehicle Trips Reduced	69,498	69,093	405
VMT Reduced (miles)	1,247,480	1,245,657	1,823
Emissions Reduced			
NOx (daily tons)	0.2571	0.2564	0.0007
VOC (daily tons)	0.2056	0.2045	0.0011
CO2 (annual tons)	119,083.0	118,884.7	198.3

Appendix 6, continued

COMMUTER CONNECTIONS
EMPLOYER SERVICES PARTICIPATION LEVELS
(EFFECTIVE Retroactively to July 1, 2015)
October 20, 2015

SUPPORT STRATEGIES

Likely range of trip reduction **0%**

- Expresses Interest and/or distributes/displays information on Ozone Actions Days

LEVEL 1 (BRONZE)

Likely range of trip reduction **0% to 1%**

- Expresses interest in telework, transit benefits, Smart Benefits, or other TDM strategy
- Conducts Commuter Survey
- Distributes alternative commute info to employees
- Posts alternative commute information on employee bulletin board(s), intranet sites, newsletter or e-mail
- Installs Electric Car Charging Station(s) at worksite

LEVEL 2 (SILVER) – Implements two or more of the following strategies

Likely range of trip reduction **0% to 3% without Telework/Compressed Work Schedules**
0% to 9% with Telework/Compressed Work Schedules

- Installs a permanent display case or brochure holders and stock with alternative commute information
- Installs electronic screens or desktop feed of real-time travel information for transit and/or other alternative mode availability.
- Participates in the Capital Bikeshare Program as a Corporate Partner
- Provides preferential parking for carpools and vanpools
- Implements a telework program with 1-20% of employees participating
- Facilitates car/vanpool formation meetings
- Hosts/sponsors an alternative commute day or transportation fair
- Implements flex-time or staggered work schedule
- Implements compressed work week for 1-20% of employees
- Installs bicycle racks or lockers
- Installs shower facilities for bicyclists and walkers
- Establishes an ETC who regularly provides alternative commute information to employees
- Becomes a Commuter Connections member and provides on-site ridematching
- Supplements GRH program with payment for additional trips or own program

Appendix 6, continued

LEVEL 3 (GOLD)

Implements at least one of the following (in addition to the two or more Level 2 strategies):

Likely range of trip reduction **2% to 5% without financial incentive/disincentive, Telework/Compressed Work Schedules**
5% to 20% with financial incentive/disincentive, Telework/Compressed Work Schedules

- Implements a telework program with more than 20% of employees participating
- Implements compressed work week for 21%+ of employees
- Implements a transit/vanpool benefit, Smart Benefits, Federal Bicycle Benefit, or parking "cash out" program
- Implements a carpool/bicycle/walk benefit
- Provides free or significantly reduced fee parking for carpools and vanpools (valid only for companies where employees pay for parking)
- Implements a parking fee (valid only for companies that previously did not charge for parking)
- Provides employee shuttle service to transit stations
- Provides company vanpools for employees' commute to work
- Implements a comprehensive Bicycle/Walking program (includes installation of showers bicycle racks/lockers, and financial incentives for bicycling and/or walking, or a Capital Bikeshare Station)

LEVEL 4 (PLATINUM)

Likely range of trip reduction **2% to 8% without financial incentive, Telework/Compressed Work Schedules**
5% to 30% with financial incentive, Telework/Compressed Work Schedules

- Implements two or more of the Level 3 TDM programs (in addition to the 2 or more Level 2 strategies) and actively promotes these programs and alternative commuting

Appendix 7
Calculation of Mass Marketing Impacts

7 impact components
- Part 1 – Commuters influenced by ads to change mode – no contact CC (direct influence)
- Part 2 – 'Pool Rewards carpool/vanpool incentive participants
- Part 3 – Car-Free Day event
- Part 4 – incenTrip mobile application
- Part 5 – Bike to Work Day event
- Part 6 – Commuters influenced by ads to contact CC (referred influence)
- Part 7 – Commuters influenced by ads to join GRH (referred influence)

PART 1 – Direct Ad Influence

Populations of Interest – commuters influenced by ads to change mode – no contact CC

Total commuters in region	2,055,050	(2022 SOC)
• % recall any commute message	28%	(2022 SOC)
• % recall CC/COG commute message	5.9%	(2022 SOC)
• % chg to alt mode after CC/COG ads	14.8%	(2022 SOC)
• % changers influenced by ad	50%	(2022 SOC)
Placements – no contact with CC	**8,973**	(Commuters x CC recall X change % x influence %)

Placement Rates

• Continued placement rate	28%	(2022 SOC)
• Temporary placement rate	72%	(2022 SOC)

Placements

• Continued placements	2,512	(Placements x continued placement rate)
• Temporary placements	6,461	(Placements x temporary placement rate)

Daily Vehicle Trips Reduced

• Continued VTR factor	0.65	(2022 SOC)
• Temporary VTR factor	0.65	(2022 SOC)
• Temporary duration factor	4%	(2022 SOC)
• Continued VT reduced	1,633	(Continued placements x continued VTR factor)
• Temporary VT reduced	168	(Temporary placements x temporary VTR factor x 4% credit for temporary use – Ave use of 2 weeks/50 work weeks)
Total Daily Vehicle Trips Reduced	**1,801**	

Daily VMT Reduced

• Ave one-way trip distance (mi)	21.0	(2022 SOC)
Total Daily VMT Reduced	**37,821**	

Appendix 7, continued

PART 1 (Direct Ad Influence) (cont.)

Trip and VMT Adjustment for SOV Access to HOV Modes (reduce VT and VMT for AQ analysis)

• SOV access percentage	23%	(2022 SOC – transit riders)
• SOV access distance (mi)	2.6	(2022 SOC – transit riders)

Adjusted VT Reduction

• SOV access VT	414	(Total VT x SOV access %)
• VT with no SOV access	1,387	(Total VT – SOV access VT)

Adjusted VMT Reduction

• SOV access VMT	1,076	(Total VT x SOV % x access distance)
• VMT with no SOV access	36,745	(Total VMT – SOV access VMT)

Total VT for AQ analysis	**1,387**
Total VMT for AQ analysis	**36,745**

PART 2 – 'Pool Rewards Carpool/Vanpool Participants

Carpool Component

FY 2021-FY 2023 program participants	101
Pre-FY 2021 program participants	204

Vanpool Component

Vanpool program participants (FY 2021-23)	76

Placement Rates – by retention after program ended

Carpool Component

• Continued placement rate	98%	('Pool Rewards follow-up survey)
• Temporary placement rate	2%	('Pool Rewards follow-up survey)
• Pre-FY 21 retained placement rate	54%	('Pool Rewards follow-up survey)

Vanpool Component

• Continued placement rate	100%	('Pool Rewards NTD vanpool data)
• Temporary placement rate	0%	('Pool Rewards NTD vanpool data)

Placements

Carpool Component

• Continued placements	99	(FY 21-23 participants x continued placement rate)
• Temporary placements	2	(FY 21-23 participants x temporary placement rate)
• Retained placements	110	(Pre-FY 21 participants x retained placement rate)
Carpool placements	**211**	

Vanpool Component

• Continued placements	76	(Participants x continued placement rate)
• Temporary placements	0	(Participants x temporary placement rate)
Vanpool placements	**76**	
Total 'Pool Rewards placements	**287**	

Appendix 7, continued

PART 2 ('Pool Rewards) (cont.)

Daily Vehicle Trips Reduced

Carpool Component		
• Continued VTR factor	0.64	('Pool Rewards follow-up survey)
• Temporary VTR factor	0.62	('Pool Rewards logging data for program period)
• Temporary discount	50%	(assumes 13 weeks of program + 13 weeks after program)
• Retained VTR factor	0.56	('Pool Rewards follow-up survey)
• Continued VT reduced	63	(Continued placements x continued VTR factor)
• Temporary VT reduced	1	(Temporary placements x temporary VTR factor x 50% credit for temporary use)
• Retained VT reduced	62	(Retained placements x retained VTR factor)
Carpool VT Reduced	**126**	
Vanpool Component		
• Continued VTR factor	1.56	('Pool Rewards NTD vanpool data)
• Temporary VTR factor	N/A	('Pool Rewards NTD vanpool data)
• Temporary discount	N/A	(No temporary vanpools)
• Continued VT reduced	119	(Continued placements x continued VTR factor)
• Temporary VT reduced	0	(Temporary placements x temporary VTR factor x 50% credit for temporary use)
Vanpool VT Reduced	**119**	
Total Daily Vehicle Trips Reduced	**245**	

Daily VMT Reduced

Carpool Component		
• Ave cont/temp one-way trip dist (mi)	22.8	('Pool Rewards follow-up survey)
• Ave retained one-way trip dist (mi)	24.7	('Pool Rewards follow-up survey)
• Continued/Temp VMT reduced	1,459	(Continued VT reduced x continued trip distance)
• Retained VMT reduced	1,531	(Retained VT reduced x retained trip distance)
Carpool VMT Reduced	**2,990**	
Vanpool Component		
• Ave continued one-way trip dist (mi)	35.0	('Pool Rewards NTD vanpool data)
• Ave temporary one-way trip dist (mi)	N/A	(No temporary vanpools)
• Continued VMT reduced	4,165	(Continued VT reduced x continued trip distance)
• Temporary VMT reduced	0	(Temporary VT reduced x temporary trip distance)
Vanpool VMT Reduced	**4,165**	
Total Daily VMT Reduced	**7,155**	

Appendix 7, continued

PART 2 ('Pool Rewards) (cont.)

Trip and VMT Adjustment for SOV Access to HOV Modes (reduce VT and VMT for AQ analysis)

• SOV access percentage (carpool)	69%	(SOC survey)
• SOV access percentage (vanpool)	86%	(Placement survey)
• SOV access distance (mi) (carpool)	6.0	(SOC survey)
• SOV access distance (mi) (vanpool)	7.0	(Placement survey)

Adjusted VT Reduction

Carpool Component

• SOV access VT	87	(Total VT x SOV access %)
• **VT with no SOV access**	**39**	(Total VT – SOV access VT)

Vanpool Component

• SOV access VT	102	(Total VT x SOV access %)
• **VT with no SOV access**	**17**	(Total VT – SOV access VT)

Adjusted VMT Reduction

Carpool Component

• SOV access VMT	522	(Total VT x SOV % x 6.0 mi access distance)
• **VMT with no SOV access**	**2,468**	(Total VMT – SOV access VMT)

Vanpool Component

• SOV access VMT	714	(Total VT x SOV % x 7.0 mi access distance)
• **VMT with no SOV access**	**3,451**	(Total VMT – SOV access VMT)

Total VT for AQ analysis	**56**
Total VMT for AQ analysis	**5,919**

PART 3 – Car Free Day Event

Pledges

Total participants	10,881	(Pledges, 2020, 2021, 2022)
Number of unique participants	6,927	(Pledges, 2020, 2021, 2022 adjusted for participation in more than one event)

Placements (day of event)

• Participated in CFD for work trip	86%	(2023 CFD follow-up survey)
• Used new alt mode for work trip	20%	(2023 CFD follow-up survey)
• Event day commute placement rate	17%	(86% work participation x 20% new mode for work trip)
• Event day placements	1,850	(Participants x placement rate)

Total Event Day Placements	**1,850**

Event Impacts

Daily Vehicle Trips Reduced

• Event day VTR factor	1.21	(CFD follow-up survey)
• Event VT reduced	2,239	(Placements x event VTR factor)
• **Equivalent daily VT**	**3**	(Event VT reduced / 750 days over 3 years)

Appendix 7, continued

PART 3 (Car-Free Day) (cont.)

Event Impacts (continued)

Daily VMT Reduced

• Ave one-way trip distance (mi)	12.8	(CFD follow-up survey)
• Event VMT reduced	28,659	(Event VT reduced x 12.8 trip distance)
• **Equivalent daily VMT**	**38**	(Event VMT reduced / 750 days over 3 years)

Car Free Day Ongoing Impacts (from continued use of new alt modes for commuting after event)

Placements (ongoing following event)

• Number of unique participants	6,927	Calculated above
• Participant employed %	97%	(CFD follow-up survey)
• Cont placement rate (increased alt use)	9%	(CFD follow-up survey)
• Post-event ongoing placements	605	(Participants x employed % x placement rate)
Total Ongoing Placements	**605**	

Daily Vehicle Trips Reduced

• Ongoing VTR factor (after CFD)	0.72	(CFD follow-up survey)
• **Ongoing daily VT reduced**	**436**	(Ongoing participants x ongoing VTR factor)

Daily VMT Reduced

• Trip distance	12.8	(CFD follow-up survey)
• **Ongoing daily VMT**	**5,581**	(Ongoing daily VT x trip distance)

Total Impacts – Event Day + Ongoing

Total Daily VT Reduced	**439**	(Event equivalent daily VT + ongoing daily VT)
Total Daily VMT Reduced	**5,619**	(Event equivalent daily VMT + ongoing daily VMT)

PART 4 – incenTrip Program

Populations of Interest

Number of active registrants	3,587	
% also registered in GRH	55%	(Credit for these registrants is counted in GRH)
Adjusted base without GRH	**1,614**	
% who logged commute trips	81%	
Adjusted base for commute impacts	**1,307**	

Placement Rates and Placements

• Continued placement rate	42.9%	(CC placement survey)
• Temporary placement rate	16.9%	(CC placement survey)
• Continued placements	561	(Registrants x continued placement rate)
• Temporary placements	221	(Registrants x temporary placement rate)
Total Placements	**782**	

Appendix 7, continued

PART 4 (incenTrip) (continued)

Daily Vehicle Trips Reduced

• Continued VTR factor	0.38	(CC placement survey)
• Temporary VTR factor	0.38	(CC placement survey)
• Temporary discount	20.0%	(CC placement survey)
• Continued vehicle trips reduced	213	(Registrants x continued placement rate)
• Temporary vehicle trips reduced	17	(Registrants x temporary placement rate x temp discount)
Total Daily Vehicle Trips Reduced	**230**	

Daily VMT Reduced

• Continued distance (mi)	18.6	(CC placement survey)
• Temporary distance (mi)	18.6	(CC placement survey)
• Continued VMT reduced	3,962	(Registrants x continued placement rate)
• Temporary VMT reduced	316	(Registrants x temporary placement rate x temp discount)
Total Daily VMT Reduced	**4,278**	

Summary of Travel Impacts for Parts 1, 2, 3, 4

	Total 1,2,3,4	Direct Ads	'Pool Rewards	Car Free Day	incenTrip
Placements (ongoing)	10,647	8,973	287	605*	782
Vehicle Trips Reduced	2,715	1,801	245	439	230
VMT Reduced (miles)	54,873	37,821	7,155	5,619	4,278
Air Quality Adjusted VT / VMT					
Vehicle Trips Reduced	2,112	1,387	56	439	230
VMT Reduced (miles)	52,561	36,745	5,919	5,619	4,278

* Car Free Day ongoing placements = e.g., commuters who switched to alt mode for continued commuting after event

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Emissions Reduced – NOx (Daily), VOC (Daily) and CO2 (Annual) – Parts 1, 2, 3,4

NOx	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	2,112	0.9596			2,027	0.0022
• From Running			52,561	0.1501	7,889	0.0087
Total NOx reduced (tons)					**Daily**	**0.0109**

VOC	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	2,112	2.1585			4,559	0.0050
• From Running			52,561	0.0575	3,022	0.0033
Total VOC reduced (tons)					**Daily**	**0.0083**

Appendix 7, continued

Emissions Reduced – NOx, VOC, CO2 – Parts 1, 2, 3, 4 (continued)

CO2	Trips	23 Emission Factor	VMT	23 Emission Factor	Tot gm	Tot ton
• From Starts	2,112	208.68			440,732	0.486
• From Running			52,561	348.43	18,313,829	20.188
Total CO2 reduced (tons)					**Daily**	**20.674**
					Annual	**5,168.5**

PART 5 - Bike To Work Day Credit

Participants' riding percentage and frequency

Number of riders	14,265	(BTWD registration data, 2020, 2021 and 2022 adjusted for some participation in previous year)
% biking to work before event	85.9%	(BTWD survey)
% new riders	6.5%	(BTWD survey)
Number of new riders	927	
% who increase riding days	15.3%	(BTWD survey)
Number of increased riders	2,183	
Total placements	**3,110**	(Total new + increased riders)

Change in Bike Days

Summer Biking

% new riders in summer	5.4%	(BTWD survey)
Weekly new bike days summer	1.1	(BTWD survey)
Weekly new bike days summer	847	(total riders x % new ride summer x ave days biking summer)
% increased riders in summer	13.3%	(BTWD survey)
Weekly increased bike days summer	1.6	(BTWD survey)
Weekly increased bike days summer	3,036	(total riders x % inc ride summer x ave days biking summer)

Winter Biking

% new riders biking winter	5.1%	(BTWD survey)
Weekly new bike days winter	1.0	(BTWD survey)
Weekly new bike days winter	728	(total riders x % new ride winter x ave days biking winter)
% increased riders biking winter	10.9%	(BTWD survey)
Weekly increased bike days winter	1.6	(BTWD survey)
Weekly increased bike days winter	2,488	(total riders x % incr ride winter x ave days biking winter)

Additional Bike Days (New and Increased Riding)

• NEW/INC bike days summer	3,883	(weekly new and increased bike days summer)
• NEW/INC bike days fall-winter	3,216	(weekly new and increased bike days winter)
• Total additional bike days summer	108,724	(new/inc weekly summer days x 28 weeks – Apr-Oct)
• Total additional bike days winter	70,752	(new/inc weekly winter days x 22 weeks – Nov-Mar)
• Total additional bike days - year	179,476	(summer bike days + winter bike days)
• Additional bike trips - year	358,952	(annual bike days x 2 trips per day)

Appendix 7, continued

PART 5 (Bike To Work Day) (continued)

Additional Bike Trips and Vehicle Trip and VMT Reductions

• Ave new daily bike trips	1,436	(Annual new bike trips / 250)
• % Drive alone/CP/VP on non-bike days	44%	(BTWD survey)
BTWD Daily Vehicle Trips Reduced	**632**	(daily new bike trips x DA/CP/VP percentage)

Daily VMT Reduced

• Ave trip distance (mi)	7.8	(BTWD survey)
BTWD Daily VMT Reduced	**4,930**	(vehicle trips reduced x average trip distance)

Emissions Reduced – NOx (Daily), VOC (Daily) and CO2 (Annual) – Bike To Work Day

NOx	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	632	0.9596			606	0.0007
• From Running			4,930	0.1501	740	0.0008
Total NOx reduced (tons)					**Daily**	**0.0015**

VOC	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	632	2.1585			1,364	0.0015
• From Running			4,930	0.0575	283	0.0003
Total VOC reduced (tons)					**Daily**	**0.0018**

CO2	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	632	208.68			131,886	0.145
• From Running			4,930	348.43	1,717,760	1.894
Total CO2 reduced (tons)					**Daily**	**2.039**
					Annual	**509.8**

PART 6 – Referred Influence (Commuter Operations Center)

Mass Marketing received a 2.2% portion of the impacts calculated for the Commuter Operation Center. This credit recognized that 20% of commuters who were new COC applicants and made a commute change reported in the Applicant Placement survey that they learned of Commuter Connections through a Mass Marketing advertisement or action. New applicants accounted for 11.0% of the total COC applicants (Excluding Retained Past applicants). This calculation resulted in 2.2% of the COC credit being assigned to Mass Marketing (11.0% new apps x 20% influence).

Populations of Interest – commuters influenced by ads to contact CC

New CC apps (does not include re-apply or follow-up)

• FY 2021	918	(CC database)
• FY 2022	2,134	(CC database)
• FY 2023	2,563	(CC database)
Total new applicants	**5,615**	
Total CC applicants	51,018	(includes new, re-apply, and follow-up)

Appendix 7, continued

PART 6 – Referred Influence to COC (continued)
Populations of Interest – commuters influenced by ads to contact CC

New apps FY 2021-23 as % of total	11.0%	(new apps FY 2021-23 / total CC apps)
% influenced by ads to contact CC	20.0%	(COC applicant analysis; 2020 Applicant placement survey)
% ALL apps influenced by ads	2.2%	(11.0% new apps x 20.0% influenced by ads)

COC Impacts – MM Share (2.2% of total COC base for each impact below – COC base is defined in Appendix 8)

Travel Impacts	COC Base	MM Share
• COC placements	28,756	633
• COC Vehicle trips reduced	6,209	137
• COC VMT reduced	143,428	3,155
Emissions Impacts	**COC Base**	**MM Share**
• NOx reduced (daily tons)	0.0276	0.0006
• VOC reduced (daily tons)	0.0196	0.0004
• CO2 reduced (annual tons)	13,488.9	296.8

1) COC Base included only FY 2021-FY 2023 impacts; it excludes retained credit

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PART 7 – Referred Influence to GRH – From GRH Analysis

About 8% of the FY 2021 – FY 2023 GRH impacts were assigned to Mass Marketing to recognize that 26% of new GRH applicants were influenced to apply for GRH after hearing a Mass Marketing advertisement. These new applicants accounted for 47% of the total GRH applicants (Reapply + New) during FY 21-23. Impacts generated through Retained GRH users (35% of total GRH impacts) were excluded from the base. This calculation resulted in 8% of the GRH credit being assigned to Mass Marketing (47% x 26% new apps x 65% non-retained impacts).

Total GRH apps FYs 21, 22, 23	3,308		
New GRH apps FY 21, 22, 23	1,568	47%	
Estimated MM share of new GRH	26%		
FY 2021-23 VMT as % of total VMT	65%		(Exclude Retained credit from discount)
Estimated MM share of GRH impact	**8%**		(47% of total applicants x 26% MM credit-new applicants x 65% new/reapply)

GRH Impacts – MM Share (6% of total GRH base for each impact below)

Travel Impacts	GRH Base	MM Share
• GRH placements	1,392	111
• GRH Vehicle trips reduced	1,296	104
• GRH VMT reduced	35,769	2,862
Emissions Impacts	**GRH Base**	**MM Share**
• NOx reduced (daily tons)	0.0060	0.0005
• VOC reduced (daily tons)	0.0037	0.0003
• CO2 reduced (annual tons)	3,105.7	248.5

1) GRH Base included only FY 2021-FY 2023 impacts; it excludes retained credit

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Appendix 7, continued

Mass Marketing – Summary

Total – Sum of PART 1, PART 2, PART 3, PART 4, PART 5, PART 6, PART 7 (See above for individual calculations)

	Total MM	Direct Ad Infl	'Pool Rewards	Car Free Day	incenTrip	BTW	COC Credit	GRH Credit
Placements	14,501	8,973	287	605	782	3,110	633	111
VT reduced	3,588	1,801	245	439	230	632	137	104
Perc total MM VT		50%	7%	12%	6%	18%	4%	3%
VMT reduced	65,820	37,821	7,155	5,619	4,278	4,930	3,155	2,862
Emissions Reduced								
NOx (daily T)	0.0135		0.0109			0.0015	0.0006	0.0005
VOC (daily T)	0.0108		0.0083			0.0018	0.0004	0.0003
CO2 (annual T)	6,223.6		5,168.5			509.8	296.8	248.5

Appendix 8
Calculation of Commuter Operations Center Impacts

PART 1 – Commute Information Requests

Populations of Interest – Commuter Connections Rideshare Applicants

FY 2021-23 Applicant Base (New credit) New, Reapply, Transit/other, follow-up requests

• FY 2021	16,762	(CC database)
• FY 2022	17,317	(CC database)
• FY 2023	16,939	(CC database)
New FY 2021-23 assisted commuters	**51,018**	

Pre-FY 2021 Applicant Base (Retained credit)

• Applicants Pre-FY 2021	14,639	(CC database)
• Valid contact percentage	63%	(Retention rate survey)
• Est percentage NOT full-time TW	70%	(Retention rate survey)
Retained Pre-FY 2018 applicant base	**6,456**	

Distribution of In/Out NAA

FY 2021-23 Applicant Base (New)			
Within NAA	45%	22,958	(Commuter Connections placement survey)
Outside NAA	55%	28,060	(Commuter Connections placement survey)
Pre-FY 2018 Applicant Base (Retained)			
Within NAA	45%	2,905	
Outside NAA	55%	3,551	

COC Placement Rates and Placements

(NAA applicant base x NAA placement rate; calculated for continued, temporary, and retained cases)

FY 2021-23 Applicants (New)	**Pl Rate**	**Placements**	
• Within NAA – continued rate	44.5%	10,216	(Commuter Connections placement survey)
• Within NAA – temporary rate	11.7%	2,686	(Commuter Connections placement survey)
• Outside NAA – continued rate	42.9%	12,038	(Commuter Connections placement survey)
• Outside NAA – temporary rate	13.6%	3,816	(Commuter Connections placement survey)
Pre-FY 2021 Registrants (Retained)			
• Within NAA – continued rate	14.3%	415	(Retention rate survey)
• Outside NAA – continued rate	14.3%	508	(Retention rate survey)
Total Placements		**29,679**	

VTR Factors and Daily Vehicle Trips Reduced (continued only)

(NAA cont placement x NAA cont VTR factor); (NAA temp placement x NAA temp VTR factor x temp discount)

FY 2021-23 Applicants (New)	**VTR Factor**	**VT Reduced**	
• Temporary discount	20.0%		
• Within NAA – continued VTR factor	0.23	2,350	(Commuter Connections placement survey)
• Within NAA – temporary VTR factor	0.50	269	(Commuter Connections placement survey)
• Outside NAA – continued VTR factor	0.25	3,010	(Commuter Connections placement survey)
• Outside NAA – temporary VTR factor	0.76	580	(Commuter Connections placement survey)

Appendix 8, continued

PART 1 – Commute Information Requests (continued)

Pre-FY 2018 Applicants (Retained)

• Within NAA – continued VTR factor	0.80	332	(Retention rate survey)
• Outside NAA – continued VTR factor	0.80	406	(Retention rate survey)

Total Daily Vehicle Trips Reduced	**6,947**

Commute Distance and Daily VMT Reduced

(VMT reduced is calculated as number of vehicle trips reduced x one-way travel distance; individual calculations are performed for continued, temporary, and retained placements and for both Within the NAA and Outside the NAA)

FY 2021-23 Applicants (New)

Distances in miles derived from Commuter Connections placement survey

	O-W Dist	**VMT Reduced**	
• Within NAA - continued distance	23.1	54,285	
• Within NAA – temporary distance	23.1	6,214	
• Outside NAA – continued distance	23.1	69,531	(Actual outside distance 49.0 miles)
• Outside NAA – temporary distance	23.1	13,398	(Actual outside distance 49.0 miles)

Pre-FY 2018 Applicants (Retained)

Distances in miles derived from Commuter Connections placement survey

• Within NAA – continued distance	19.6	6,507	
• Outside NAA – continued distance	19.6	7,958	

Total Daily VMT Reduced	**157,893**

Trip and VMT Adjustment for SOV Access to HOV Modes (reduce VT and VMT for AQ analysis)

FY 2021-23 Applicants (New)

Inside NAA	Cont	Temp	
• SOV access percentage	64%	64%	(Placement survey)
• SOV access distance (mi)	3.1	3.1	(Placement survey)

Outside NAA (N/A - all access VT and VMT occur outside NAA)

Pre-FY 2021 Applicants (Retained)	Cont	
• SOV access percentage	70%	(Retention survey)
• SOV access distance (mi)	4.6	(Retention survey)

Adjusted VT Reduction – net of drive alone access

(Calculated as Within NAA VTs x SOV access % for continued, temporary, and retained placements)

• Total VT reduced	6,947	Calculated above
• Within NAA access VT (deduct)	- 1,908	(Total SOV access VTs for cont, temp, retained cases)
• Outside NAA access VT	0	No deduction (access trips are outside NAA)
Total VT (net of SOV access)	**5,039**	

Appendix 8, continued

PART 1 – Commute Information Requests (continued)

Adjusted VMT Reduction – net of VMT access

• Total VMT reduced	157,893	Calculated above
• Within NAA access VMT (deduct)	- 6,262	(Total SOV access VMTs for cont, temp, retained cases)
• Outside NAA access VMT	0	No deduction (access VMT are outside NAA)
Total VMT (net of SOV access)	**151,631**	
Total VT for AQ analysis	**5,039**	
Total VMT for AQ analysis	**151,631**	

Emissions Reduced – NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	5,039	0.9596			4,835	0.0053
• From Running			151,631	0.1501	22,760	0.0251
Total NOx reduced (tons)					**Daily**	**0.0304**

VOC	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	5,039	2.1585			10,877	0.0120
• From Running			151,631	0.0575	8,719	0.0096
Total VOC reduced (tons)					**Daily**	**0.0216**

CO2	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	5,039	208.68			1,051,539	1.159
• From Running			151,631	348.43	52,832,789	58.238
Total CO2 reduced (tons)					**Daily**	**59.397**
					Annual	**14,849.3**

Correction for Overlap between COC Base and Other Program Elements

The COC supports several other TDM program elements, including Mass Marketing, Software Upgrades, GRH, incenTrip, and portions of the COC base impact are deducted from the COC and assigned to those program elements. Details of the determination of each credit are presented in the relevant appendices. The "Net COC Base" is calculated as the initial/total COC base minus the sum of credits for Mass Marketing, Software Upgrades, GRH, and incenTrip.

	COC Base	**MM**	**Soft Upg**	**GRH**	**incenTrip**	**Net COC Base**
Placements	29,679	633	3,596	8,904	227	**16,319**
Vehicle Trips Reduced	6,947	137	669	2,084	67	**3,990**
VMT Reduced (miles)	157,893	3,155	15,454	47,368	1,241	**90,675**
Emissions Reduced						
NOx Reduced (daily tons)	0.0304	0.0006	0.0030	0.0091	0.0003	**0.0174**
VOC Reduced (daily tons)	0.0216	0.0004	0.0022	0.0065	0.0003	**0.0122**
CO2 (annual tons)	14,849.3	296.8	1,468.8	4,454.8	163.2	**8,465.7**

Appendix 8, continued

Correction for Overlap between COC Base and Integrated Rideshare and GRH (continued)
Notes:

- MM influenced commuters – from MM analysis (see Appendix 7)
- Share of COC assigned to GRH = 30% of COC credit; calculated as the share of COC apps that were new apps/reapps (42%) and who registered for GRH (72%) = (72% x 42% = 30%). The GRH credit is not added to the GRH impact; rather it is assumed to be an overlap and is deducted from the COC impact to avoid duplication.
- Software Upgrade component is calculated in Appendix 8.
- Share of incenTrip that overlaps with COC (subtracted from COC base) = 29%; percentage of incenTrip users who also registered for COC (2020 Applicant Placement Rate survey)

PART 2 – Telework Credit (Non-Maryland origin / destination)

- Credit for telework assistance provided directly to commuters who do not live or work in Maryland; credit for Maryland residents/workers is assigned to the Telework Assistance program element

NOTE: Calculation details for the Non-Maryland Telework credits below are shown in Appendix 4 (Telework)

Number of regional teleworkers	2,136,576	(State of Commute survey)
% of non-MD teleworkers	57%	(% of regional TWers who live and work outside MD)
Number of teleworkers (non-MD)	1,211,439	
Share of TW credited to COC	4.4%	(% of TWers used TW from Commuter Connections)
Total TW placements credited to COC	53,303	
Vehicle trips reduced	15,058	
VMT reduced	207,288	
Daily NOx reduced (tons)	0.0502	
Daily VOC reduced (tons)	0.0489	
Annual CO2 reduced (tons)	20,769.8	

Final Commuter Operations Center Credit – Including Base COC and Telework Credit
Net COC = Net COC Base + Non-MD TW

	Net COC Base	Non-MD TW	Net COC
Placements	16,319	53,303	**69,622**
Vehicle Trips Reduced	3,990	15,058	**19,048**
VMT Reduced (miles)	90,675	207,288	**297,963**
Emissions Reduced			
NOx Reduced (daily tons)	0.0174	0.0502	**0.0676**
VOC Reduced (daily tons)	0.0122	0.0489	**0.0611**
CO2 (annual tons)	8,465.7	20,769.8	**29,235.5**

Appendix 9
Calculation of Integrated Rideshare (Software Upgrades) Impacts

Populations of Interest – Commuter Connections Rideshare Applicants
All data factors (Placement rate, VTR factors, trip distances) derived from Applicant Placement survey

Populations of Interest – Commuter Connections Rideshare Applicants
FY 2021-23 Applicant Base (New credit) New, Reapply, Transit/other, follow-up requests

• FY 2021	16,762	(CC database)
• FY 2022	17,317	(CC database)
• FY 2023 (through Dec 2022)	16,939	(CC database)
New FY 2021-23 assisted commuters	**51,018**	
Within NAA (45%)	22,958	
Outside NAA (55%)	28,060	

COC Placement Rates	**In NAA**	**Out NAA**	
• Continued rate	2.9%	4.1%	(CC placement survey)
• Temporary rate	3.6%	3.4%	(CC placement survey)

Placements (Continued and Temporary; In NAA and Outside NAA)

• Continued	666	1,150	(Applications x continued rate)
• Temporary	826	954	(Applications x temporary rate)

Total placements	**3,596**

Daily Vehicle Trips Reduced (Continued and Temporary; In NAA and Outside NAA)

VTR Factors	**In NAA**	**Out NAA**	
• Continued	0.23	0.25	(CC placement survey)
• Temporary	0.50	0.76	(CC placement survey)
• Temporary discount	20.0%	20.0%	(CC placement survey)
• Continued trips reduced	153	288	(Placements x cont. VTR factor)
• Temporary trips reduced	83	145	(Placements x temp VTR factor x temp discount)

Total VT reduced	**669**

Daily VMT Reduced (Continued and Temporary; In NAA and Outside NAA)

Ave one-way trip distance (mi)	**In NAA**	**Out NAA**	
• Continued	23.1	23.1	(Actual Outside dist. 49.0 miles)
• Temporary	23.1	23.1	(Actual Outside dist. 49.0 miles)
• Continued VMT reduced	**3,534**	**6,653**	(Cont VT x ave trip distance)
• Temporary VMT reduced	**1,917**	**3,350**	(Temp VT x ave trip distance)

Total VMT Reduced	**15,454**

Appendix 9, continued

Trip and VMT Adjustment for SOV Access to HOV Modes (reduce VT and VMT for AQ analysis)

	In NAA	Out NAA	
• SOV access % -Continued	64%	0%	(CC placement survey)
• SOV access dist (mi) – Continued	3.1	0.0	(CC placement survey)
• Non-SOV access % - Temporary	64%	0%	(CC placement survey)
• SOV access dist (mi) – Temporary	3.1	0.0	(CC placement survey)

Outside NAA – not applicable – all access outside NAA

VT Reduction	**In NAA**	**Out NAA**	
• Continued SOV access VT	98	0	(Total cont VT x SOV access)
• Temporary SOV access VT	53	0	(Total temp VT x SOV access)
• Continued VT (without SOV access)	55	288	(Total cont VT – SOV access VT)
• Temporary VT (without SOV access)	30	145	(Total temp VT- SOV access VT)

Total VT (net of SOV access) 518

VMT Reduction	**In NAA**	**Out NAA**	
• Continued SOV access VMT	304	0	(Total cont VT x SOV % x access dist)
• Temporary SOV access VMT	164	0	(Total temp VT x SOV % x access dist)
• Continued VMT (without SOV access)	3,230	6,653	(Total cont VMT- SOV access VMT)
• Temporary VMT (without SOV access)	1,753	3,350	(Total temp VMT- SOV access VMT)

Total VMT (net of SOV access) 14,986

Total VT for AQ analysis 518
Total VMT for AQ analysis 14,986

<u>Emissions Reduced</u> – NOx (Daily), VOC (Daily) and CO2 (Annual)

NOx	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	518	0.9596			497	0.0005
• From Running			14,986	0.1501	2,249	<u>0.0025</u>
Total NOx reduced (tons)					**Daily**	**0.0030**

VOC	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	518	2.1585			1,118	0.0012
• From Running			14,986	0.0575	862	<u>0.0010</u>
Total VOC reduced (tons)					**Daily**	**0.0022**

CO2	**Trips**	**23 Emission Factor**	**VMT**	**23 Emission Factor**	**Tot gm**	**Tot ton**
• From Starts	518	208.68			108,096	0.119
• From Running			14,986	348.43	5,221,572	<u>5.756</u>
Total CO2 reduced (tons)					**Daily**	**5.875**
					Annual	**1,468.8**

Appendix 10
Reduction in Delay Due to TDM Program-Related VMT Reduction

The TDM Revised Evaluation Framework for FY 2015-17 highlighted the opportunity to develop new performance indicators to document societal benefits, such as mobility, health, safety, livability, and quality of life, that are generated by the Commuter Connections TDM program. Performance-based planning and established goals in the region may consider the impact of TDM program elements on the performance of the highway system. For this reason, the revised evaluation framework noted "reduction in travel delay" as an emerging metric that seeks to develop a direct relationship between VMT reduction and improved system performance.

As used in this analysis, "travel delay" refers specifically to vehicle hours of delay. Person hours of delay are typically calculated from vehicle hours of delay by applying an assumed or known vehicle occupancy factor. For example, if two people are riding in a vehicle in congestion, both experience the delay, so the person hours of delay would be twice the vehicle hours of delay. However, because this TDM analysis calculates delay reduction from elimination of single-occupant vehicles, each vehicle in the analysis includes only one person, so the hours of delay calculated in this section represents both vehicle hours of delay and person hours of delay.

Ideally, reduction in vehicle hours of delay from use of TDM program elements would be calculated by measuring the travel speed on regional roads with the programs in place, estimating the lower speed that would be experienced if vehicle trips and VMT eliminated by the programs were still on the road, and comparing the conditions with programs to the assumed conditions without programs to estimate an aggregate delay reduction. Practically, this method has multiple issues, such as the need to estimate differential speeds by network links and assign trips reduced to network links to estimate where and when delay is reduced. It also would be necessary to account for non-recurring delay, such as occurs during a roadway incident or regional event.

These issues make the ideal calculation beyond the current scope of the TDM analysis, but the research team designed a substitute method that estimates the average hours of delay for a known number of VMT and applying it to the program element VMT reduction that would have occurred on congested roads. This calculation requires two steps. The first examines overall delay reduction and calculates a VMT to delay factor to convert VMT into hours of delay across the regional system. The second step is to estimate the share of TDM program element VMT reduced that would be traveling on congested roadways if the programs did not exist. This reduced VMT count is used because a mile traveled on a road with no congestion does not create or add to travel delay, so miles on uncongested roadways would be excluded from the benefit calculation.

Step 1 – Estimate overall regional delay reduction

This first step establishes a relationship between TDM impacts and system performance; specifically, between VMT reduced by a TDM program (TDM impact) to delay reduction (easing congestion over levels that likely would have occurred in the absence of the program elements). This relationship will be in the form of a conversion factor.

In assessing the economic impacts of system performance, researchers have established the concept of "*marginal added delay.*" Marginal added delay results from the presence of one extra vehicle on the road and is measured in added hours of delay per thousands of passenger-car equivalent (pce) VMT. To establish this national conversion factor the evaluation team consulted the Trip Reduction Impacts of

Mobility Management Strategies (TRIMMS) model developed by the Center for Urban Transportation Research.

TRIMMS 4.0 updated the method used in earlier versions of TRIMMS to estimate the societal cost saving benefits of TDM actions for a range of societal benefits, one of which is change in marginal added delay. The marginal added delay is used to compute changes in added congestions to other vehicles on the roadway. This delay saving results from the reduction in VMT from transit and TDM strategies. The change in marginal added delay (Δ delay) is measured in added minutes of travel time per added VMT using the following formula:

$$\Delta\, Delay\ = Delay_0 \left[\left(\frac{VMT_1}{VMT_0} \right)^{\varepsilon_{d,VMT}} - 1 \right]$$

The average delay (minutes/VMT) for the Washington DC MSA is estimated from the Texas Transportation Institute's (TTI) 2015 Urban Mobility Scorecard, which covers 14 years of data (2000-2014) for 101 urban areas. VMT_1 is TRIMMS estimated VMT, VMT_0 is the baseline VMT, and $\varepsilon_{d,\,vmt}$ is the elasticity of delay with respect to VMT. For more information, refer to the TRIMMS User Manual. The TRIMMS calculation estimates a **15.9 hours of delay per 1,000 daily VMT**.[18] The TDM Analysis uses this conversion factor to evaluate the societal cost saving from reduced traffic delay.

Estimate TDM VMT Subject to Congested Conditions

The second step is to estimate the TDM program element VMT reduced that would be traveling in congested conditions if the program element services did not exist. A commuter traveling on a road with no congestion does not create or add to travel delay, so VMT on uncongested roadways are excluded from the calculation of marginal delay. This step requires information on the roads used by commuters who participate in program element services.

Three surveys conducted by COG for the FY 2021 – FY 2023 TDM analysis included questions to examine road use by commuters who participated in TDM services. The 2020 Applicant Placement Survey assessed roadways used by commuters who participated in Commuter Connections online commute information and ridematching services and incentive programs ('Pool Rewards, incenTrip, CarpoolNow, and Flextime Rewards). The 2022 GRH Survey examined roadway use for GRH participants. The 2022 State of Commute (SOC) Survey identified roadway use for ridesharers and transit riders, on days they traveled in a personal vehicle. Note that commuters who carpooled or vanpooled were asked to report the roads they used, while commuters who used only public transit were asked what roads they would expect to use if they were to drive to work.

For all three surveys, the samples of commuters using individual road segments were too small to calculate delay reductions by route. But the data were sufficient to estimate the percentage of commuters who commuted along Interstate highways and major state routes, roadways that would most likely experience congestion. In short, the survey data could be used to estimate the share of TDM VMT reduction that would have traveled on roads that experience peak period congestion. This adjusted VMT count could then be multiplied by the TRIMMS 15.9 hours of delay per 1000 daily VMT figure to estimate the hours of delay that were eliminated by the TDM-generated VMT reductions.

[18] The conversion factor of 15.9 hours of delay per 1000 VMT reduced was the same as used in the 2020 TDM Analysis Report but a significant drop from the conversion value of 62.16 used in the 2017 TERM Analysis Report. This change reflected a modification of the methodology used in the TRIMMS model to estimate delay reduction. Source: TRIMMS™ User Manual, Version 4.0, Center for Urban Transportation Research, USF.

Table 10-1 shows the estimated congested VMT to which the hours of delay per VMT factor was applied. Because each TDM program element involves a specific commuter profile, the calculation was performed first for each element separately. Then the estimated congested VMT by program element were added for a total congested VMT.

The basic calculation involves the following steps:

1 – Define TDM program element base VMT reduction

2 – Estimate percentage of commuters' VMT in congestion on major roads
- Estimate percentage of program commuters using Interstate highways (from survey data)
- Assume commuters using major roadways travel 85% of their commute miles on major roads
- Estimate 15% share of major roadway miles experience peak period congestion[19]

3 – Multiply TDM base VMT reduction x % congested major roads VMT

Table 10-1 – Calculation of Estimated Congested VMT by Individual TDM Program Element

TDM Program Element	% Commuters Using Major Roads	Base VMT Reduction	% Miles on Major Roads	Estimated Major Roadway VMT
Maryland Telework	63%	489,911	8%	39,193
Guaranteed Ride Home	86%	52,201	11%	5,742
Employer Outreach	61%	1,247,480	8%	99,798
Mass Marketing	58%	65,820	8%	5,266
Commuter Operations Center	78%	313,417	10%	31,342
All Program Elements plus COC				**181,341**

To illustrate, the calculation for the Maryland Telework Assistance is provided below:

Base VMT reduction for the TDM program element = **489,911 VMT**

Commute major road VMT % = % commuters using Interstates x % of travel miles on major roads
- 63% of teleworkers use Interstate highway (from 2022 SOC survey)
- Assume commuters using Interstates travel 85% of their commute miles on major roads
- Estimate 15% share of roadway miles experience peak period congestion

- Estimated major road VMT % for Telework = 63% x 85% x 15% = **8% major road VMT**

Major road VMT = Base VMT reduction x major road % = 489,911 x 8% = **39,193 major road VMT**

When the calculation provided above is performed for all TDM program elements, the total congested VMT across all program elements equals 181,341, or about 8.4% of the 2,168,829 total VMT reduced by the program elements and the Commuter Operations Center combined. And when the major road VMT

[19] MWCOG produces a biennial Congestion Management Process Report, which provides statistics on various aspects of roadway network performance. The 2020 report for 2019 reported that 27% of Interstate roadways miles in the region and 11% of the non-Interstate National Highway System roads were congested during the morning peak period. The 2022 report for 2021 reported corresponding values of 16% for Interstate and 6% for non-Interstate NHS roads. To obtain a composite value to represent FY 21-FY 23, the evaluation team averaged these four values to estimate 15% congested miles for the roadways in the analysis.

total is multiplied by the 15.9 hours of delay per 1000 VMT reduced, the estimated hours of delay reduced equals 2,883 daily hours of delay reduced:

Estimated delay reduction = (181,341 / 1,000) x 15.9 hours per mile = **2,883 daily hours delay reduced**

The calculation shown above uses survey or other measured data on road use to the extent the data are available, but some assumptions are required in the calculation. As noted at the beginning of this appendix, the samples of commuters using individual roads were too small for direct road-by-road analysis of delay impacts. Thus it is not currently possible to estimate the delay reduction impacts of TDM program elements on specific locations or highway segments. However, by applying the delay reduction calculation only to the share of VMT that would be expected to travel on road segments that experience congestion, the calculation estimates a conservative impact for the delay reduction benefit.

Appendix 11
Calculation of Societal Benefits Generated by TDM Program Element Impacts

Since its inception in 1997, the Commuter Connections TDM analysis has been undertaken primarily to document travel and emissions impacts of each program element and compare the impacts against the goals set for the elements. This remains a central focus of the analysis for the FY 2021 – FY 2023 analysis. But the program elements likely do offer other benefits to residents and commuters of the Washington region, in societal objectives such as greenhouse gas emissions reductions, greater mobility, improved road safety, and enhanced transportation system performance.

These benefits have joined congestion and air quality as forces shaping the region's transportation policies, making them also issues relevant to Commuter Connections partners and funders. Documenting the types and magnitude of these benefits demonstrates the broad value of Commuter Connections programs to the community and the value of investments made in the programs. Documenting these contributions also supports the regional response to the federally-mandated, performance-based planning and programming (PBPP) process required of states and MPOs. Under this requirement, COG must track a variety of performance indicators related to transportation system performance, such as hours of peak hour excessive roadway delay.

The FY 2021 – FY 2023 TDM evaluation included an analysis component to estimate regional cost savings generated for selected societal benefits of the TDM program elements' travel and emissions impacts. These benefits include the following:

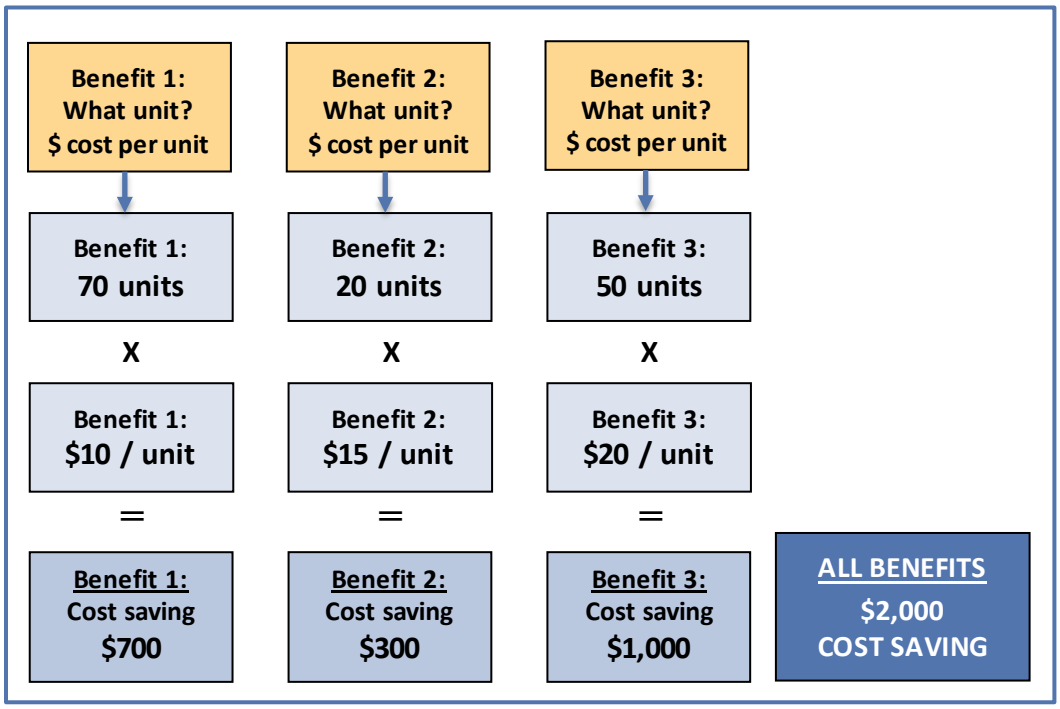
- Air pollution/emissions reductions in NOx and VOC
- Greenhouse gas emissions (CO2) reduction
- Reduction in congestion (reduced hours of travel delay)
- Reduction in fuel consumption (gasoline cost saving)
- Improved road safety (crashes reduced per 1 million VMT)
- Noise pollution reduction (reduced motor vehicle noise)

Figure 11-1 shows the basic method for calculating societal cost savings. The approach requires defining the unit of benefit associated with each type of benefit and cost per unit of benefit. The calculation then multiplies the benefit units by a unit cost factor and sums the individual benefit cost savings for a total across all benefits.

Define Units of Benefits and Cost Saving per Benefit Unit – First, the analysis must define a unit measure that represents performance for each benefit. For example, the benefit unit for traffic congestion reduction is the vehicle hours of peak period travel delay reduced and the unit of benefit for reduction in fuel consumption is gallons of gasoline saved (not used). The analysis also must define for each benefit the financial value, or societal cost saving, that a unit of benefit provides. For travel delay reduction, the unit cost is typically a value of time equal to an hourly wage rate. For fuel consumption saving, the unit cost would be the average cost of a gallon of gasoline.

Calculate Total Benefit Units – After the benefit units have been defined, the analysis calculates the number of units of benefits generated. The method to calculate units of benefit is specific to the benefit, so the methods can vary by benefit, but in this TDM analysis, all are derived from some measure of travel behavior impact, such as reductions in vehicle trips and/or vehicle miles traveled (VMT).

Figure 11-1 – Example Calculation of Societal Benefits Cost Savings for Three Benefits



Continuing the example of travel delay reduction, the analysis calculates the number of hours of travel delay that the TDM program element eliminated. This count is made by estimating the VMT removed from congested roadway segments, then dividing that VMT count by a conversion factor of hours of delay reduced per 1000 daily VMT. Other benefits have similar but unique formulas to convert travel changes into benefit units. These conversion methods are described later in this appendix.

Calculate Cost Saving for Each Benefit and Total Cost Saving – The societal cost saving for each benefit is then calculated by multiplying the number of benefit units by the cost saving per unit factor. The cost saving for delay reduction would be calculated by multiplying the hours of travel delay reduced by the average wage rate for workers in the region. Similar calculations are made for the other benefits in the TDM analysis, then the cost savings for individual benefits are summed to calculate the total cost saving for all benefits together.

In all cases, the VMT reduction was the starting point, with conversions made to translate VMT reduction into units of benefit. For most benefits, the method used to derive the units of benefit and the unit cost factors were obtained from the Trip Reduction Impacts of Mobility Management Strategies (TRIMMS™) 4.0 model developed by the Center for Urban Transportation Research (CUTR). TRIMMS™ estimates societal cost saving benefits of TDM actions for the societal benefits shown above. Following are details of the calculation methodology and calculation results for each TDM program element.

Air Pollution/Emissions Reductions and Greenhouse Gas Reductions

Air pollution has various adverse societal consequences for human health and for physical impacts on the environment. Health research has documented links between increased levels of pollution and higher levels of respiratory and cardiopulmonary illness, with the greatest risk and incidence occurring among children, the elderly, and people with related diseases. Air pollution also can have negative

environmental impacts, through reduced visibility, and damage to agricultural and forest land. Motor vehicles contribute to air pollution through pollutants emitted while vehicles are starting and operating. Thus, TDM program elements that reduce vehicle emissions contribute to less polluted air and offer benefits from reduction in the healthcare costs associated with pollution-related illness and costs incurred to repair environmental damages.

The TDM analysis calculates the societal cost of two air quality pollutants: nitrogen oxides (NOx) and volatile organic compounds (VOC). These pollutants are strongly associated with the health and environmental damage and with motor vehicle operation.

The TDM analysis also calculates the societal cost for greenhouse gas emissions, defined as tons of carbon dioxide (CO2). Its environmental role is like that of other air pollutants, in that motor vehicle emissions are a primary contributor to the problem, but unlike VOC and NOx emissions, which dissipate relatively quickly, greenhouse gas emissions accumulate over time in the atmosphere, effecting a cumulative increase in the average global temperature. A warming planet presents potentially serious and long-term environmental consequences, including more extreme drought but also more extreme storms, rising sea level that threatens coastal lands, and the loss of arctic sea ice and the ecosystems that rely on it, among other concerns.

The societal cost for emission reduction can be calculated by estimating the tons of pollutant emitted and multiplying by the societal cost of one ton of pollutant. For example, the equation for NOx cost saving would be:

Cost saving for NOx reduction = ((VMT reduced x gm/mi NOx emission factor) + (VTrips reduced x gm/trip NOx factor)) / gm per ton conversion factor x $ cost per tons NOx reduced

Calculating Benefit Units and Cost per Unit of Benefit – The emission factors are related to the types and ages of vehicles being operated and the speed and other conditions of travel and will vary by metropolitan region. They are most accurately derived through runs of emission models, such as the Environmental Protection Agency's MOVES (Motor Vehicle Emission Simulator) model used by MWCOG, which considers the types and ages of vehicles, the speed and operating conditions experienced by travelers, and atmospheric conditions, each of which can affect emission rates.

The dollar costs per ton of pollutant applied in the TDM analysis are taken from CUTR's TRIMMS™ model. As described in the TRIMMS™ User Manual (Version 4.0), TRIMMS™ uses costs associated with damage to health, visibility, and physical impact on the environment. TRIMMS™ "adopted the costs estimates of Delucchi, who estimated costs for several impact categories for urban areas of the U.S. in 1991. Delucchi updated the original values in 2005 to account for changes in information about pollution and its effects. He customizes these estimates by using regional exposure scalars to get from the average exposure basis in U.S. urban areas to the average exposure in each of the metropolitan statistical areas.

According to Delucchi, population density is the best simple measure of exposure to air pollution. The original 2005 $/Kg are converted to current dollar values using the consumer price index (CPI). These estimates are scaled to each individual region using the ratio of median household income of each area to the U.S. median household income. [20]

[20] TRIMMS™ User Manual, Version 4.0, Center for Urban Transportation Research, USF.

Cost Saving Calculation – TRIMMS™ methodology estimates benefits for various air pollution emissions. The model calculates emissions by multiplying exhaust tailpipe emission rates generated from the EPA Agency Motor Vehicle Emission Simulator (MOVES2010a) in grams per mile to the VMT reduced. But, because the TDM analysis estimates emissions using locally-specific emission factors derived by MWCOG or the regional conformity determination, the evaluation team calculated emission reductions outside of the TRIMMS™ model, but then applied the default daily costs per day by pollutant to the TDM emissions estimates to calculate air pollution societal benefit costs. The relevant emissions calculations are presented in Table J-1.

As shown, the daily benefit cost saving for all air pollutant components combined is $787 per day, comprised of $737 per day from NOx and $50 per day from VOC. The daily cost saving for greenhouse gas reductions, defined by a benefit unit of tons of CO2 reduced, equals $30,078 saved per day.

Table 11-1 - Daily Air Pollution and Climate Change Societal Benefit Cost Savings Generated by FY 2021 – FY 2023 TDM Program Elements and Commuter Operations Center Impacts

Societal Benefit	Benefit Unit	Benefit Base Units [1)]	Cost per Unit of Benefit [2)]	Total Daily Cost Saving
Air pollution				
- NOx	Tons NOx removed	0.457 T	$1,612	$737
- VOC	Tons VOC removed	0.375 T	$133	$50
Total air pollution				**$787**
Greenhouse gas	**Tons CO2 removed**	**836.0 T**	**$36**	**$30,096**

1) Daily tons of emissions reduced calculated in TDM analysis using MWCOG emission factors.
2) Cost per tons of emissions reduced obtained from TRIMMS™.

Noise Pollution Reduction

The societal benefit for noise pollution reduction is related to the reduced noise associated with the vehicle travel that has been eliminated from the roadway. Noise costs refer to negative externalities associated with motor vehicle noise emissions such as noise from engine acceleration and vibration, tire contact on road surfaces, and horn usage. Traffic noise is an annoyance, but has real health effects from impaired hearing, increased stress, and sleep disruption, and can contribute to reduction in property values in areas with high or sustained noise levels. An analysis of cost saving from noise pollution reduction estimates how much noise will be reduced and multiplies that reduction by a unit cost factor that represents the cost of abatement for that noise level.

Cost saving for noise reduction = Total VMT reduced
x Noise reduction per VMT reduced
x $ cost per adjusted VMT

Calculating Benefit Units and Cost per Unit of Benefit – The TDM analysis applies the approach and benefit unit and unit cost factors from the TRIMMS™ model. TRIMMS™ applies a unit benefit factor of 1.0 to convert total VMT reduced to a noise reduction component. It then multiplies the adjusted VMT by a noise costs of $0.022692 per mile for auto and vanpool and $0.115205 per mile for transit (derived from a literature review) to estimate the societal cost savings. The composite cost of $0.0223, which

includes both health and property value impacts is scaled to account for cost-of-living differentials between national averages and the Washington metropolitan region.

This calculation estimates a total cost saving for noise pollution reduction of $48,365 per day, as shown below:

Total daily VMT reduced by TDM program elements = 2,168,829

Noise pollution daily cost saving = 2,168,829 x $0.0223 per VMT = **$48,365 per day**

Congestion (Delay) Reduction

A third societal benefit is cost savings from reductions in traffic congestion. Traffic congestion slows the flow of traffic, resulting in slower travel speeds and longer trip times. Longer trips create societal dis-benefit primarily through lower business productivity, reduced access to the workforce, and loss of personal time for travelers who travel in congested conditions. The impact of traffic congestion typically is defined by the additional travel time or travel delay experienced by vehicle operators. When TDM programs remove vehicles and VMT from congested segments of road, travel speeds on those road segments increase, resulting in shorter trip times and less delay. Because the Commuter Connections TDM analysis assesses benefits related to commuting travel, the benefit unit assigned to traffic congestion in the analysis is reduced vehicle hours of peak period travel delay.

The approach used to estimate vehicle hours of delay reduction estimates the percentage share of the TDM program elements' total VMT reduced that would have traveled on congested roadways and applies a per VMT delay factor to the reduced VMT to estimate the reduced hours of delay. For example, if 20% of the VMT reduced would have traveled on congested roadways during the peak period, how many additional hours of travel delay would be expected? The hours of delay reduced are then multiplied by a cost per hour of delay to estimate the total cost saving from reduced congestion.

Cost saving for reduced congestion = Congested VMT reduced
x Marginal delay hours per VMT
x $ cost per hour of delay

Calculating Benefit Units and Cost per Unit of Benefit – The calculation of "congested VMT" discounted the total VMT reduced to include only miles traveled on Interstate highways and major roadways in the Washington metropolitan region. The method additionally discounted to include only VMT that would have traveled in congested conditions to align with the marginal delay factor used by TRIMMS™ to convert VMT reduced into hours of delay reduction across the regional system. This factor is a national default value of **15.9 hours of marginal delay per 1,000 passenger car equivalent daily VMT**.

The unit cost of an hour of delay, often referred to as the value of travel time savings (VTTS), reflects the opportunity cost of time spent traveling that could be used for other activities. The demand for travel is derived from the benefit of accessing a destination, rather than the travel itself. Thus, time spent traveling has a negative value and a reduction in travel time represents a positive benefit. In its simplest form, the value of travel time saving includes costs to businesses in lost productivity and costs to travelers in lost personal time.

Transportation economic analyses typically value an hour of time saved as a labor wage rate. The VTTS will depend on the traveler, the circumstances of the trips, and the travel alternatives. The U.S. Department of Transportation (USDOT) published Departmental guidance regarding value of time for transportation economic analyses to "assist analysts in developing consistent evaluations of actions that

save cost or time in travel."[21] For commuting, when travelers have a defined and non-discretionary trip purpose (getting to/from work), and for TDM strategies, which most often are available to a wide range of commuters, a cost saving analysis can reasonably approximate VTTS over the working population, using an average hourly wage rate over all commuters. USDOT guidance recommends using a VTTS of 100% of the median hourly wage rate, including benefit costs, for "on-the-clock" local business/ commercial travel and 50% of the median hourly wage rate, excluding benefits, for personal travel.

However, a consideration that is of great relevance to analysis of the TDM program elements is that the value travelers place on a congested minute appears to be different than the value for non-congested time, as much as 1.5 to 2.5 times the value of time spent in uncongested travel, depending on the extent of congestion. A substantial body of transit and mode choice research has documented differential values of in-vehicle travel time, out-of-vehicle wait time, and transfer times for transit. Travelers experience wait time and transfer time as longer than the actual time and experience travel time as shorter than actual time. For example, the USDOT guidance recommends that personal time spent walking or waiting, as is common for the rideshare, transit, bicycle, and walking trips generated by TDM strategies, also be valued at 100% of wage rate.

The average wage rate for the TDM analysis would be a composite rate comprised primarily of the local personal travel value, which would suggest a value closer to 50% than 100% of the local wage rate. However, as noted above, USDOT applies a 100% value to access/wait time for travel in non-drive alone modes, which are the focus of the TDM program elements. Finally, the role of congestion in commuting can be significant, suggesting the wage rate applied should be account be closer to 100% than 50%. For simplicity, the TDM analysis uses a single VTTS of 100% of median hourly wage rate, excluding worker benefits. This number was chosen as an approximation because it is readily available from the U.S. Bureau of Labor Statistics.[22]

Cost Saving Calculation – The adjusted "major roadway" VMT calculation estimated that 181,169, or about 8.4% of the total VMT reduced by the Commuter Connections TDM program would have traveled on major roadways in congested conditions. When this "congested VMT" total is multiplied by the 15.9 hours of delay per 1000 VMT reduced, the estimated hours of delay reduced by the TDM program equals 2,881 daily hours of delay reduced:

Estimated delay reduction = (181,341 mi / 1,000) x 15.9 hours per daily VMT = **2,883 daily hours delay reduced.**

These hours of delay were multiplied by the $30.43 median hourly wage rate for all employees working in the Washington metropolitan region, as reported by the Bureau of Labor Statistics. When this cost is multiplied by the 2,883 daily hours of delay reduced, the total congestion (delay) reduction benefit equals **$87,730 per day**.

Excess Fuel Consumption Reduction

A reduction in vehicle use results in a direct reduction in the amount of fuel consumed for travel. The TDM analysis defines the societal benefit of reducing fuel use as the cost saved when gallons of fuel are not purchased. Reduced vehicle use also results in other vehicle operating savings, such as reduced

[21] The U.S. Department of Transportation (USDOT), September 28, 2011, Memorandum Subject: Revised Departmental Guidance on Valuation of Travel Time in Economic Analysis.
https://www.transportation.gov/sites/dot.dev/files/docs/vot_guidance_092811c.pdf

[22] U.S. Department of Labor, Bureau of Labor Statistics (BLS) wage data May 2022 – median hourly wage rate for all occupations combined; https://www.bls.gov/oes/current/oes_nat.htm.

vehicle maintenance and depreciation, but these costs are excluded from the analysis. The cost saving for reduction in fuel use is calculated by converting the VMT reduction into gallons of fuel saved and multiplying by an average fuel cost per gallon:

Cost saving for reduced fuel consumption = Total VMT reduced
/ Fuel consumption factor (miles per gallon)
x $ cost per gallon of fuel

Calculating Benefit Units and Cost per Unit of Benefit – Fuel consumption has a direct relationship with the number of vehicle miles traveled and is commonly defined by dividing the total VMT by the miles per gallon (mpg) fuel consumption rate. Fuel consumption per mile varies by vehicle type and by travel speed and operating conditions. For example, a large sport utility vehicle (SUV) uses more gasoline per mile or per hour than does a small compact car. And vehicles use different amounts of fuel when traveling as slow speeds than high speeds, with higher speeds generally more efficient use of fuel. The societal benefit calculation estimated a weighted average fuel economy by type of vehicle and model year and the percentage of each vehicle type in the national fleet in 2022. This calculation yielded an average of 23.2 miles per gallon fuel efficiency. This factor represents the average fuel economy of a typical commuting vehicle in the passenger vehicle fleet, including both large and small vehicles, cars, SUVs, and vans and trucks used as commuting vehicles.[23]

The gallons of fuel saved by reduced VMT is multiplied by an average cost per gallon of fuel. The U.S. Energy Information Administration publishes average gasoline prices for various parts of the country. Over the three years covered by the evaluation period, the average fuel price reported for the Mid-Atlantic region was $3.40 per gallon.[24] The result of these calculations is as follows:

Total daily VMT reduced by TDM program elements = 2,168,829

Estimated gallons of fuel saved = 2,168,829 miles / 23.2 miles per gallon = 93,484 gallons

Excess fuel consumption daily cost saving = 93,484 gallons x $3.40 per gallon = **$317,846 per day**

The calculation estimates a fuel saving of 93,484 gallons per day and a cost saving from reduction in fuel use of $317,846 per day.

Improved Road Safety (Crash Reduction)

A reduction in motor vehicle travel generates a benefit of improved road safety by reducing the likelihood of a motor vehicle crash occurring. Quite simply, as vehicles are removed from a roadway, the remaining vehicles have a reduced risk of crashes. The cost saving from reduced vehicle crashes is equal to the reduced risk of a crash multiplied by the economic cost of the average crash.

The TDM analysis applies the road safety/crash reduction approach from the Health and Safety element of the TRIMMS™ methodology. TRIMMS™ applies expected crash rates for crashes of various severities to estimate an overall crash probability per 1 million VMT. In the TDM analysis, this crash risk factor is multiplied by the total VMT reduced by the TDM program elements to estimate the number of likely

[23] Data on production shares and production-weighted fuel economy from the Bureau of Transportation Statistics. https://www.bts.gov/content/productions-production-shares-and-production-weighted-fuel-economies-new-domestic-and. Data for percentage of vehicles in the national fleet by model year from Hedges Company; https://hedgescompany.com/blog/2022/02/how-old-are-cars/. All data sourced on May 22, 2023.
[24] Weekly Retail Gasoline and Diesel Prices, June 2020. U.S. Energy Information Administration. https://www.eia.gov/dnav/pet/pet_pri_gnd_dcus_r1y_m.htm.

crashes by severity that would have been avoided by the reduction in vehicle travel. The number of anticipated crashes is then multiplied by the average cost per crash to estimate the total cost saving:

Cost saving for improved road safety = Total VMT reduced x Expected crashes per 1,000,000 VMT x $ cost per crash

Calculating Benefit Units and Cost per Unit of Benefit – The value of reduced crashes is calculated by multiplying the estimated number of crashes by severity by the cost per occurrence of each crash type. TRIMMS™ estimates a composite cost per unit benefit (crash avoided) that includes vehicle crash-related monetary costs for property and personal injury damages caused by collisions, and nonmonetary costs, for pain and loss of productivity. The TRIMMS™ methodology starts with the VMT reduction and applies a multi-level calculation that considers the occurrence probability of crashes with varying levels of severity (KABCO Injury Classification Scale)[25] and the average cost per type of crash. Crashes with minor property damage have a higher likelihood of occurring but a lower cost per occurrence. Conversely, crashes with serious or fatal injuries are less likely to occur but have a high societal cost when they do happen. Table 11-2 shows crash types, occurrence probabilities and anticipated costs.

The calculation in Table 11-2 produces an average composite risk of 1.01136 vehicle crashes per 1 million VMT and an average weighted cost per crash of $15,952. Note that this crash cost accounts for both the high probability (1.0000 per 1M VMT) but low cost ($3,650) of a no injury crash and the low probability (0.0076 per 1M VMT) but high cost ($1.4 M) of a fatal injury cost.

Table 11-2 – Crash Costs by Injury Severity and Weighted Cost of Crashes

KABCO Injury Classification Scale	Probability per 1 M VMT	Cost per Occurrence	Expected Cost per 1 M VMT [1)]
No injury (O)	1.00000	$3,650	$3,650
Possible injury (C)	0.00055	$55,768	$31
Non-incapacitating evident injury (B)	0.00011	$2,828	$3
Incapacitating injury (A)	0.00194	$783,341	$1,520
Fatal injury (K)	0.00776	$1,408,533	$10,930
Overall probability and cost	1.01136		$16,134
Weighted cost per 1 M VMT [2)]			**$15,952**

1) Expected cost per 1 million VMT = Probability of occurrence in 1 million VMT x average cost per occurrence.
2) Weighted cost per 1 million VMT = Overall cost ÷ Overall probability.

The TDM analysis estimates that 2.193 crashes will occur over the 2.169 million VMT reduction. At a per occurrence cost of $15,952, the total cost saving from crash reduction is $34,983 per day.

Total daily VMT reduced by TDM program elements = 2,168,829

Expected crash occurrence = (2,168,829 miles / 1,000) x 1.01136 crash per 1000 VMT = 2.193 crashes

Health and Safety daily cost saving = 2.193 crashes x $15.952 per crash = **$34,983 per day**

[25] Federal Highway Administration. (2017, June 30). *KABCO Injury Classification Scale and Definitions.* Retrieved from FHWA Highway Safety Improvement Program - Safety Performance Management : https://safety.fhwa.dot.gov/hsip/docs/fhwasa18001.pdf Table 9 on p30 has comprehensive crash costs in 2017 dollars. Table 39 https://safety.fhwa.dot.gov/hsip/docs/fhwasa17071.pdf shows costs per state.

Total Societal Benefit Cost Saving

Table 11-3 presents the cost saving associated with each type of benefit and the overall societal cost saving calculated for the four TDM program elements and the Commuter Operations Center combined.

Table 11-3 – Societal Benefit Cost Savings Generated by TDM Program Elements (FY 2021 – FY 2023)

Societal Benefit	Benefit Unit	Benefit Base Units	Cost per Unit of Benefit	Total Daily Cost Saving
Air pollution				
- NOx	Tons NOx removed	0.457 T	$1,612	$737
- VOC	Tons VOC removed	0.375 T	$133	$50
Greenhouse gases	Tons CO2 removed	836.0 T	$36	$30,096
Noise pollution	Total VMT reduced	2,168,829 VMT	$0.0223	$48,365
Congestion	Hours of delay reduced	2,883 hours	$30.43	$87,730
Excess fuel used	Gallons of fuel saved	93,484 gal	$3.40	$317,846
Health/safety [1)]	Crashes avoided/1 M VMT	2.193 crashes	$15,952	$34,983
All benefits				**$519,807**

1) Health and safety benefit base units and cost per unit are weighted averages of crash occurrences by severity.

As shown, the combination of the TDM program elements and Commuter Operations Center generate about $519,807 of daily cost saving across the societal benefits included in the calculation. The largest share of the cost saving is in reduction of excess fuel used; this benefit is valued at over $317,846 per day, or about 61% of the total daily benefits. Reduction in hours of travel delay accounts for about 17% of the total daily benefit ($87,730). Noise pollution reduction generates about 9% and the air pollution/ greenhouse gas reduction combined benefits and road safety crash reduction benefits are responsible for about 6% and 7%, respectively, of the total cost saving.