Appendix

Merrimack Valley Metropolitan Planning Organization

Federal Fiscal Years 2020 to 2024 Transportation Improvement Program

Appendix Draft Report

April 2019

Prepared by the Merrimack Valley Planning Commission

This document was prepared in cooperation with the Massachusetts Department of Transportation and the U.S. Department of Transportation. (under Contracts #95416, #MA-80-012 and #MA-80-013 with MassDOT) The views and opinions of the Merrimack Valley Planning Commission expressed herein do not necessarily state or reflect those of the Massachusetts Department of Transportation or the U.S. Department of Transportation.

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Appendices

Appendix A and B: Other Regional Priorities

Appendix A Other Regional Priority Bridge Projects

(No Funding Available)

Bridges That Do Not Fit into Fiscally Constrained Targets, and therefore have No Funding Available in Any Year (By Town):

ID	Location	Project Description	Estimated Total Project Cost
602322	Ames.	Amesbury - Bridge Replacement, A-07-008, Oak Street Over the B&M Railroad (Abandoned Line)	$1,000,000
	And.	Andover - Rehab. Bridge (A-09-001) Route 28 (North Main Street) Over the Shawsheen River	
605418	And.	Andover - Bridge Preservation, A-09-028, Chandler Road over I-93	$3,450,000
604839	Law.	Lawrence – Bridge Replacement, L-04-027, Lowell Street over B&M Railroad	$4,473,000
	Law.	Lawrence - Bridge Rehabilitation, L-04-042, South Union Connector over South Street	
	Nbypt.	Newburyport - Bridge (N-11-002) State Route 113 (High Street) Over Railroad	
	Nbypt.	Newburyport - Bridge (N-11-014) State Route 1A (High Street) over US 1	
607115	Nbypt.	Newburyport - Bridge Repairs, N-11-015, Washington St. over US 1	$1,400,000

Appendix B Other Regional Priority Roadway Projects

(No Funding Available)

Roadway Projects That Do Not Fit into Fiscally Constrained Targets, and therefore have No Funding Available in Any Year (By Town)

ID	Location	Project Description	Estimated Total Project Cost
608336	Andover	Andover – Reconstruction on Route 133 (Lowell Street), from Lovejoy Road to Route 28 (North Main Street) TEC = 11.00	$7,245,000
607708	Andover	Andover - Resurfacing and related work on Route 28 TEC = 5.22	$1,062,600
606721	Boxford	Boxford - Reconstruction of Route 133 (Washington Street) from North Andover town line to Main Street TEC = 5.60	$5,172,164
	Boxford	Boxford Reconstruction of Route 97 from Georgetown to Topsfield (2 miles)	$3,785,000
607540	Boxford	Boxford - Border to Boston Trail TEC = 3.32	$4,174,500
602843	Georgetown	Georgetown – Reconstruction on Route 97 (W. Main Street) from Moulton Street to Groveland T.L. TEC = 6.63	$7,239,453
	Haverhill	Haverhill -Intersection Improvements Route 110 and Elliott Street	
	Haverhill	Haverhill – Widen Route 97 (Broadway) from Computer Drive to Research Drive	

Appendix B Other Regional Priority Roadway Projects (Continued)

(No Funding Available)

Roadway Projects That Do Not Fit into Fiscally Constrained Targets, and therefore have No Funding Available in Any Year (By Town):

ID	Location	Project Description	Estimated Total Project Cost
608721	Haverhill	Haverhill – Corridor Improvements on Water Street (Route 97/113), from Ginty Boulevard/Mill Street to Lincoln Boulevard/Riverside Avenue TEC = 8.18	$8,050,000
602339	Haverhill	Haverhill-Historic Waterfront Walkway Phase II (Construction)	$3,110,184
	Lawrence/ North Andover	Lawrence - North Andover - Reconstruction of Route 114 from I-495 in Lawrence to Rt. 125 (Andover St.) in North Andover TEC = 13.05	
	Methuen	Methuen – Reconstruction of Route 110 from Burnham Road to Woodland Street	
	Newbury-port	Newburyport -Route 1 Rotary Reconfiguration	
608029	Newbury-port	Newburyport - Intersection Improvements Route 1 at Merrimac Street TEC = 7.67	$2,400,000

Appendix B Other Regional Priority Roadway Projects (Continued)

(No Funding Available)

Roadway Projects That Do Not Fit into Fiscally Constrained Targets, and therefore have No Funding Available in Any Year (By Town):

ID	Location	Project Description	Estimated Total Project Cost
	North Andover	North Andover – Reconstruction of Mass. Ave. and Sidewalks (from Osgood St. to I-495)	
605694	North Andover	North Andover - Resurfacing and related work Route 125 TEC = 7.45	$7,910,592
	North Andover	North Andover - Signals and turn lanes at Mass Ave. and I-495 NB and SB Ramps	
607710	Salisbury	Salisbury – Resurfacing and related work Route 1A	$2,300,000

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Appendix C Transportation Evaluation Criteria Summary

Appendix C Transportation Evaluation Criteria Summary

Programmed for Funding in Draft TIP	ID#	Project Description	Project Cost in 1000s	AADT	Linear Lane Miles	Condition	Mobility	Safety & Security	Community Effects & Support	Land Use & Economic Development	Environmental Effects	Total TEC Score (2020-2024)
No		Lawrence –North Andover - Reconstruction of Rt. 114 from I-495 to Rt. 125 (Andover St.)		30,000	5.6	3.00	3.00	3.00	1.80	1.75	0.50	**13.05**
Yes	608095	North Andover – Reconstruction of Rt. 114 from Rt. 125 (Andover St.) to Stop & Shop	$16,730	30,000	4.8	2.00	2.75	2.67	1.40	1.75	0.75	**11.32**
Yes	608930	Lawrence – LMRC Rail Trail	$14,895	NA	NA	1.00	1.75	2.00	3.00	2.50	1.00	**11.25**
No	608336	Andover – Rt. 133 reconst. Lovejoy Road to Shawsheen Square (inc. Shawsheen Square)	$7,245	12,773	4.4	2.00	2.75	2.00	1.00	1.75	1.50	**11.00**

Appendix C Transportation Evaluation Criteria Summary (Cont.)

Programmed for Funding in Draft TIP	ID#	Project Description	Project Cost in 1000s	AADT	Linear Lane Miles	Condition	Mobility	Safety & Security	Community Effects & Support	Land Use & Economic Development	Environmental Effects	Total TEC Score (2020-2024)
Yes	608761	Haverhill - Intersection Improvements at Rt. 110 / Rt. 108	$1,944	NA	NA	1.50	1.75	1.67	1.20	1.75	1.00	**8.87**
Yes	602202	Salisbury – Reconstruction of Route 1 (Lafayette Road)	$6,331	12,147	4.8	2.00	2.00	2.00	0.60	1.5	0.5	**8.60**
No	608721	Haverhill - Corridor Improvements on Water St. from Ginty Blvd / Mill St. to Lincoln Ave./ Riverside Ave.	$8,050	20,200	2	1.50	1.75	1.33	1.60	1.25	0.75	**8.18**
Yes	608788	Haverhill - Reconstruction of North Ave. from Main St. to NH stateline	$12,213	13,172	4	2.50	1.75	1.00	2.00	0.00	0.75	**8.00**

Appendix C Transportation Evaluation Criteria Summary (Cont.)

Programmed for Funding in Draft TIP	ID#	Project Description	Project Cost in 1000s	AADT	Linear Lane Miles	Condition	Mobility	Safety & Security	Community Effects & Support	Land Use & Economic Development	Environmental Effects	Total TEC Score (2020-2024)
No	608029	Newburyport – Intersection Improvements Rt. 1 at Merrimac St.	$2,400	24,850	NA	2.00	0.50	2.67	1.00	1.25	0.25	**7.67**
No	605694	North Andover – Route 125 Resurfacing and related work	$7,911	20,400	9.4	2.50	1.00	1.00	1.20	1.25	0.50	**7.45**
Yes	608027	Haverhill – Bradford Rail Trail extension	$1,088	NA	NA	0.50	1.50	1.00	2.40	1.25	0.50	**7.15**
No	609251	Lawrence – Intersection Improvements at South Broadway (Route 28) and Mount Vernon St.	$1,110	NA	NA	2.00	1.00	2.00	2.00	1.00	0.00	**7.02**

Appendix C Transportation Evaluation Criteria Summary (Cont.)

Programmed for Funding in Draft TIP	ID#	Project Description	Project Cost in 1000s	AADT	Linear Lane Miles	Condition	Mobility	Safety & Security	Community Effects & Support	Land Use & Economic Development	Environmental Effects	Total TEC Score (2020-2024)
No	602843	Georgetown – Route 97 from Moulton St. to Groveland TL	$7,239	15,486	2.2	1.50	0.75	1.33	0.80	1.50	0.75	**6.63**
No	606721	Boxford - Route 133 (North Andover TL to Main St.)	$5,172	6,149	2.9	1.50	1.00	1.00	0.60	0.50	1.00	**5.60**
No	607708	Andover – Route 28 resurfacing and related work	$1,063	19,728	4.0	2.50	0.25	0.67	0.80	0.50	0.50	**5.22**
Yes	607542	Georgetown – Square to Byfield (Northern) section of Border to Boston Trail	$3,876	NA	NA	0.50	1.25	0.67	0.80	1.50	0.50	**5.22**
Yes	607541	Georgetown- Boxford– south of Square to Georgetown Road (Southern) section of Border to Boston Trail	$1,735	NA	NA	0.50	1.25	0.67	0.80	1.25	0.75	**5.22**

Appendix C Transportation Evaluation Criteria Summary (Cont.)

Programmed for Fund-ing in Draft TIP	ID#	Project Description	Project Cost in 1000s	AADT	Linear Lane Miles	Condition	Mobility	Safety & Security	Community Effects & Support	Land Use & Economic Development	Environmental Effects	Total TEC Score (2020-2024)
Yes	608298	Groveland - Community Trail	$1,985	NA	NA	0.50	1.25	0.67	1.20	1.00	0.25	**4.87**
No	607540	Boxford – section of Border to Boston Trail	$4,175	NA	NA	0.50	1.00	0.67	0.40	0.50	0.25	**3.32**

Appendix D Sample Project Evaluation Worksheet

Sample Project Evaluation Worksheet
Merrimack Valley Planning Commission and MassDOT Evaluation Criteria
Project: Andover - Reconstruct Rt. 133 from Lovejoy Rd to Rt. 28 Project #: 608336
Project Cost: $7,245,000 AADT: 12,773 Distance: 2.2 Linear Lane Miles: 4.4

Condition	Score	Additional Comments
A. Magnitude of pavement condition improvement.	2	PNF indicates longitudinal & lateral pavement cracking, utility patch failure, shoving and rutting of pavement along route.
B. Magnitude of improvement of other infrastructure.	2	Current shoulder width 0' to 2', project to increase shoulder width to 4' or 5' for bikes and > safety for pedestrians, upgrade signals, drainage improvements
Condition Average	**2.0**	

Mobility	Score	Additional Comments
A. Effect on magnitude and duration of congestion.	3	Adding left turn lanes at intersection at MA-133/ Lovejoy /Greenwood. Also Rt 133/ Rt 28 improvements
B. Effect on travel time and connectivity / access.	2	Widening shoulder, realigning Rt 133/ Lovejoy and adding left turn lanes.
C. Effect on other modes using the facility.	3	Widening shoulder for bicycles, sidewalks on both sides.
D. Effect on regional and local traffic.	3	Widening shoulder, adding left turn lanes. Additional connector I-495 to I-93. NHS roadway.
Mobility Average	**2.75**	

Sample Project Evaluation Worksheet (Cont.)

Project: Andover - Reconstruct Rt. 133 from Lovejoy Rd to Rt. 28 Project #: 608336

Safety and Security	Score	Additional Comments
A. Effect on crash rate compared to State average.	3	PNF Rt 133/ Lovejoy / Greenwood has a crash rate of .94, District 4 average is .78 and the arterial between two signalized intersections is 3.8, Avg. is 2.12. Have had 1 pedestrian with injuries and 1 bicycle crash.
B. Effect on bicycle and pedestrian safety.	2	Widening shoulder for bicycles and provides greater safety for pedestrians.
C. Effect on transportation security and evacuation routes/	1	Is an NHS roadway. Is an evacuation route.
Safety and Security Average	**2.00**	

Community Effects and Support	Score	Additional Comments
A. Residential effects: ROW, noise, aesthetics, cut through traffic, and other.	2	For the most part all within ROW. General appearance and less noise from better pavement conditions.
B. Public, local government, legislative, and regional support.	2	
C. Effect on service to minority or low-income neighborhoods. (Title VI and EJ)	0	Not Title VI or EJ area.
D. Other impacts / benefits to minority or low-income neighborhoods. (Title VI and EJ).	0	Not Title VI or EJ area.
E. Effect on development and redevelopment of housing	1	
Community Effects and Support Average	**1.00**	

Sample Project Evaluation Worksheet (Cont.)

Project: Andover - Reconstruct Rt. 133 from Lovejoy Rd to Rt. 28 Project #: 608336

Land Use and Economic Development	Score	Additional Comments
A. Business effects; ROW, noise, traffic, parking, freight access, other.	2	Improve access to existing businesses.
B. Sustainable development effects. Consistent with MVPGS.	2	Access to MVPGS Rolling Green Regional PDA. Improves transportation choice (walk/bike) for area residents.
C. Consistent with regional land-use and economic development plans and PGS.	2	Access to MVPGS Rolling Green Regional PDA. Improves transportation choice (walk/bike) for area residents.
D. Effect on job creation.	1	Should provide better access to Brickstone Square State PDA.
Land Use and Economic Development Average	**1.75**	

Sample Project Evaluation Worksheet (Cont.)

Project: Andover - Reconstruct Rt. 133 from Lovejoy Rd to Rt. 28 Project #: 608336

Environmental Effects	Score	Additional Comments
A. Air quality / Climate effects. GHG Impact Description – Assumed Nominal Decrease in Emissions from Other Improvements	2	Adding bike lanes and sidewalks. Reducing delays at intersections.
B. Water quality/supply effects; wetlands effects.	1	There will be deep sump catch basins
C. Historic and cultural resources effects.	3	Shawsheen Village Historic District
D. Effect on wildlife habitat and endangered species.	0	Not endangered species habitat area.
Environmental Effects Average	**1.5**	
Overall Project TEC score	**11.00**	

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Appendix E Greenhouse Gas (GHG) Monitoring and Evaluation

2020 - 2024
Transportation Improvement Program
Greenhouse Gas Monitoring and Evaluation

Introduction

This section summarizes the greenhouse gas (GHG) impacts that are anticipated to result from the projects that are included in this FFY 2020 – 2024 Transportation Improvement Program (TIP). It includes a summary of the state laws and policies that call for reducing greenhouse gas in order to mitigate global climate change, actions that are being taken to respond to these state laws and policies, the role of regional planning and TIP development in reducing GHG emission and tracking these reductions, and the projected GHG emission impacts from the projects programmed in the TIP.

State Policy Context

The Global Warming Solutions Act (GWSA), which was signed into law in August 2008, makes Massachusetts a leader in setting aggressive and enforceable GHG reduction targets, and implementing policies and initiatives to achieve these targets. In keeping with the law, on December 29, 2010 the Massachusetts Executive Office of Energy and Environmental Affairs (EOEEA), in consultation with other state agencies and the public, released the Massachusetts *Clean Energy and Climate Plan for 2020*. In December 2014 the Department of Environmental Protection issued new regulations that require Metropolitan Planning Organizations to quantify impacts from project investments, track progress towards reductions, and consider impacts in the prioritization of GHG impacts from project investments. The targets for overall statewide GHG emissions are:

- By 2020: 25 percent reduction below statewide 1990 GHG emission levels, and
- By 2050: 80 percent reduction below statewide 1990 GHG emission levels

GreenDOT Policy

The transportation sector is the single largest emitter of greenhouse gases, accounting for over a third of GHG emissions, and therefore the transportation sector is a key focus of the *Clean Energy and Climate Plan*. MassDOT's approach to supporting the implementation of the plan is set forth in its GreenDOT Policy Directive, a comprehensive sustainability initiative that sets three principal objectives:

- **Reduce greenhouse gas (GHG) emissions.** MassDOT will achieve this by taking GHG emissions into account in all of its responsibilities, from strategic planning to project design and construction and system operations;
- **Promote the healthy transportation modes of walking, bicycling, and public transit.** MassDOT will achieve this by pursuing multi-modal, "complete streets" design standards; providing choice in transportation services; and by working with MPOs and other partners to prioritize and program a balance of projects that serve drivers, pedestrians, bicyclists, and public transit riders, and
- **To support smart growth development.** MassDOT will achieve this by working with MPOs and other partners to make transportation investments that enable denser, smart growth development patterns that support reduced GHG emissions.

GreenDOT Policy and Metropolitan Planning Organizations

The Commonwealth's thirteen metropolitan planning organizations (MPOs) are integrally involved in helping to achieve the GreenDOT goals and supporting the GHG reductions mandated under the GWSA. The MPOs are most directly involved in helping to achieve the GHG emissions reductions under the second goal – to promote healthy transportation modes through prioritizing and programming an appropriate balance of roadway, transit, bicycle and pedestrian investments – and assist in the third goal by supporting smart growth development patterns through the creation of a balanced multi-modal transportation system. This will be realized through the transportation goals and policies espoused in the Regional Transportation Plans (RTPs), the major projects planned in the RTPs, and the mix of new transportation projects that are programmed and implemented through the TIPs. The GHG tracking and evaluation processes enable the MPOs to identify the anticipated GHG impacts of the planned and programmed projects, and also to use GHG impacts as a criterion in prioritizing transportation projects.

Regional GHG Tracking and Evaluation in RTPs

MassDOT coordinated with MPOs and regional planning agency (RPA) staffs on the implementation of GHG tracking and evaluation in development of each MPO's 2035 RTPs, which were adopted in September 2011. This collaboration has continued for the MPO's 2016 RTPs and FFYs 2020-2024 TIPs.

Working together, MassDOT and the MPOs have attained the following milestones:

- Modeling and long-range statewide projections for GHG emissions resulting from the transportation sector. Using the Boston MPO's regional model and the statewide travel demand model for the remainder of the state, GHG emissions

were projected for 2021 no-build and build conditions, and for 2035 no-build and build conditions.
- All of the MPOs included these GHG emission projections in their RTPs, along with a discussion of climate change and a statement of MPO support for reducing GHG emissions as a regional goal.

Project-Level GHG Tracking and Evaluation in the Transportation Improvement Program

It is also important to monitor and evaluate the GHG impacts of the transportation projects that are programmed in the MPO Transportation Improvement Programs (TIP). The TIP includes both the larger, regionally-significant projects from the RTPs, which have already had their aggregate GHG impacts calculated and reported in the RTP, as well as smaller projects that are not included in the RTP but that may nevertheless have impacts on GHG emissions. The principal objective of this tracking is to enable the MPOs to evaluate expected GHG impacts of different projects and to use this information as a criterion for prioritizing and programming projects in future TIPs.

In order to monitor and evaluate the GHG impacts of TIP projects, MassDOT and the MPOs have developed the following approach for identifying anticipated GHG impacts and quantifying GHG impacts of projects, when appropriate, through the TIP. Different types of projects will have different anticipated GHG emissions impacts. The different project categories are outlined on the next two pages with this region's project tracking sheets on the third page.

Calculation of GHG Impacts for TIP Projects

The Office of Transportation Planning at MassDOT provided the spreadsheets that are used for determining Congestion Management and Air Quality (CMAQ) eligibility. These spreadsheets require the same inputs as the CMAQ calculations and have been adapted to provide CO_2 impacts. The data and analysis required for these calculations is available from functional design reports that should be submitted for projects that would produce a measurable GHG impact.

- **Projects with Quantified Impacts**
    - **RTP Projects -** Major capacity expansion projects would be expected to have a significant impact on GHG emissions. However, these projects are included in the RTPs and analyzed using the statewide model or Boston regional model, which would reflect their GHG impacts. Therefore, no independent TIP calculations are required.
    - **Quantified Decrease in Emissions -** Projects that would be expected to produce a measurable decrease in emissions. The approach for

calculating these impacts is described below. These projects should be categorized in the following manner:

- **Quantified Decrease in Emissions from Traffic Operational Improvement -** An intersection reconstruction or signalization project that is projected to reduce delay and congestion.
- **Quantified Decrease in Emissions from Pedestrian and Bicycle Infrastructure -** A shared-use path that would enable increased walking and biking and decreased vehicle-miles traveled (VMT).
- **Quantified Decrease in Emissions from New/Additional Transit Service -** A bus or shuttle service that would enable increased transit ridership and decreased VMT.
- **Quantified Decrease in Emissions from a Park and Ride Lot** - A park-and-ride lot that would enable increased transit ridership/ increased ridesharing and decreased VMT.
- **Quantified Decrease in Emissions from Bus Replacement** A bus replacement that would directly reduce GHG emissions generated by that bus service.
- **Quantified Decrease in Emissions from Complete Streets Improvements** Improvements to roadway networks that include the addition of bicycle and pedestrian accommodations where none were present before.
- **Quantified Decrease in Emissions from Other Improvement**

- **Quantified Increase in Emissions –** Projects that would be expected to produce a measurable increase in emissions.

- **Projects with Assumed Impacts**

  - **No Assumed Impact/Negligible Impact on Emission -** Projects that do not change the capacity or use of a facility (e.g. a resurfacing project that restores a roadway to its previous condition, or a bridge rehabilitation/replacement that restores the bridge to its previous condition) would be assumed to have no GHG impact.

- **Assumed Nominal Decrease in Emissions -** Projects that would be expected to produce a minor decrease in emissions that cannot be calculated with any precision. Examples of such projects include roadway repaving or reconstruction projects that add a new sidewalk or new bike lanes. Such a project would enable increased travel by walking or bicycling, but there may be no data or analysis to support any projections of GHG impacts. These projects should be categorized in the following manner:
  - **Assumed Nominal Decrease in Emissions from Sidewalk Infrastructure**
  - **Assumed Nominal Decrease in Emissions from Bicycle Infrastructure**
  - **Assumed Nominal Decrease in Emissions from Sidewalk and Bicycle Infrastructure**
  - **Assumed Nominal Decrease in Emissions from Intelligent Transportation Systems (ITS) and/or Traffic Operational Improvements**
  - **Assumed Nominal Decrease in Emissions from Other Improvements**

- **Assumed Nominal Increase in Emissions -** Projects that would be expected to produce a minor increase in emissions that cannot be calculated with any precision.

Regional Greenhouse Gas Impact Summary Tables for FFYs 2020 – 2024 TIP

The following tables summarize the calculated quantitative and assumed qualitative impacts of the projects included in the regional FFYs 2020 – 2024 TIP by year.

FFYs 2020 to 2024 Projects GHG Tracking Summary

2020 Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
602418	AMESBURY- RECONSTRUCTION OF ELM STREET	$7,223,053	Quantified	1,336	Quantified Decrease in Emissions from Com-plete Streets Project	$11,178,124	AC yr 2 of 2.
608027	HAVERHILL- BRADFORD RAIL TRAIL EXTENSION, FROM ROUTE 125 TO RAILROAD STREET	$848,345	Quantified	422	Quantified Decrease in Emissions from Bicycle and Pedestrian Infra-structure	$848,345	
605306	HAVERHILL- BRIDGE REPLACEMENT, H-12-039, I-495 (NB & SB) OVER MERRIMACK RIVER	$15,305,880	Qualitative		No assumed impact/ negligible impact on emissions	$118,786,388	AC yr 3 of 6.

2021 Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
608298	GROVELAND-COMMUNITY TRAIL FROM MAIN STREET TO KING STREET	$2,064,255	Quantified	2,710	Quantified Decrease in Emissions from Bicycle and Pedestrian Infra-structure	$2,064,255	
608095	NORTH ANDOVER-CORRIDOR IMPROVEMENTS ON ROUTE 114, BETWEEN ROUTE 125 (ANDOVER STREET) & STOP & SHOP DRIVEWAY	$6,813,052	Qualitative		Qualitative Decrease in Emissions	$17,399,023	AC Yr 1 of 2

2021 (Cont.) Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
607541	GEORGETOWN-BOXFORD- BORDER TO BOSTON TRAIL, FROM GEORGETOWN ROAD TO WEST MAIN STREET (ROUTE 97)	$1,812,628	Quantified	2,667	Quantified Decrease in Emissions from Bicycle and Pedestrian Infra-structure	$1,812,628	
605306	HAVERHILL- BRIDGE REPLACEMENT, H-12-039, I-495 (NB & SB) OVER MERRIMACK RIVER	$15,305,880	Qualitative		No assumed impact/ negligible impact on emissions	$118,786,388	AC Yr 4 of 6.
608494	NEWBURY-NEWBURYPORT-SALISBURY- RESURFACING AND RELATED WORK ON ROUTE 1	$9,807,200	Qualitative		Qualitative Decrease in Emissions	$9,807,200	

2022 Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
608761	HAVERHILL-INTERSECTION RECONSTRUCTION ON ROUTE 108 (NEWTON ROAD) AT ROUTE 110 (KENOZA AVENUE AND AMESBURY ROAD)	$2,099,520	Quantified	8,307	Quantified Decrease in Emissions from Traffic Operational Improve-ment	$2,099,520	
608095	NORTH ANDOVER-CORRIDOR IMPROVEMENTS ON ROUTE 114, BETWEEN ROUTE 125 (ANDOVER STREET) & STOP & SHOP DRIVEWAY	$8,684,626	Qualitative		Qualitative Decrease in Emissions	$17,399,023	AC Yr 2 of 2

2022 (Cont.) Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
605306	HAVERHILL- BRIDGE REPLACEMENT, H-12-039, I-495 (NB & SB) OVER MERRIMACK RIVER	$18,203,683	Qualitative		No assumed impact/ negligible impact on emissions	$118,786,388	AC Yr 5 of 6.

2023 Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
608788	HAVERHILL- ROADWAY RECONSTRUCTION ON NORTH AVENUE, FROM MAIN STREET (ROUTE 125) TO PLAISTOW NH	$4,147,823	Qualitative		Qualitative Decrease in Emissions	$13,678,560	AC Yr 1 of 2
602202	SALISBURY- RECONSTRUCTION OF ROUTE 1 (LAFAYETTE ROAD)	$7,090,517	Qualitative		Qualitative Decrease in Emissions	$7,090,517	
608930	LAWRENCE- LAWRENCE MANCHESTER RAIL CORRIDOR (LMRC) RAIL TRAIL	$15,950,704	Quantified	175,927	Quantified Decrease in Emissions from Bicycle and Pedes-trian Infrastructure	$15,950,704	

2023 (Cont.) Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
607542	GEORGETOWN-NEWBURY- BORDER TO BOSTON TRAIL, (NORTHERN GEORGETOWN TO BYFIELD SECTION)	$4,341,120	Quantified	15,682	Quantified Decrease in Emissions from Bicycle and Pedestrian Infra-structure	$4,341,120	
605306	HAVERHILL- BRIDGE REPLACEMENT, H-12-039, I-495 (NB & SB) OVER MERRIMACK RIVER	$15,305,880	Qualitative		No assumed impact/ negligible impact on emissions	$118,786,388	AC Yr 6 of 6.
TBD	HAVERHILL- BRIDGE REPLACEMENT, H-12-040, I-495 (NB & SB) OVER MERRIMACK RIVER	$25,198,768	Qualitative		No assumed impact/ negligible impact on emissions	$96,000,000	AC Yr 1 of 3.

2023 (Cont.) Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
608494	NEWBURY-NEWBURYPORT-SALISBURY-RESURFACING AND RELATED WORK ON ROUTE 1	$9,807,200	Qualitative		Qualitative Decrease in Emissions	$9,807,200	

2024 Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
608788	HAVERHILL- ROADWAY RECONSTRUCTION ON NORTH AVENUE, FROM MAIN STREET (ROUTE 125) TO PLAISTOW NH	$9,530,737	Qualitative		Qualitative Decrease in Emissions	$13,678,560	AC Yr 2 of 2
606522	ANDOVER- BRIDGE REHABILITATION, A-09-036, I-495 OVER ST 28 (SB), A-09-037, I-495 OVER B&M AND MBTA, A-09-041, I-495 OVER ST 28 (NB)	$17,204,394	Qualitative		No assumed impact/ negligible impact on emissions	$113,386,056	AC Yr 1 of 5

2024 (Cont.) Merrimack Valley Region MPO TIP Highway Projects GHG Tracking Summary							
Mass DOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Im-pact (kg/yr)**	**GHG Impact Description**	**Total Cost**	**Additional Information**
605304	HAVERHILL- BRIDGE REPLACEMENT, H-12-007 & H-12-025, BRIDGE STREET (SR 125) OVER MERRIMACK RIVER AND THE ABANDONED B&M RR (PROPOSED BIKEWAY)	$13,142,589	Qualitative		No assumed impact/ negligible impact on emissions	$124,938,960	AC Yr 1 of 5.
TBD	HAVERHILL- BRIDGE REPLACEMENT, H-12-040, I-495 (NB & SB) OVER MERRIMACK RIVER	$43,180,558	Qualitative		No assumed impact/ negligible impact on emissions	$96,000,000	AC Yr 2 of 3.

2020 Merrimack Valley Region Transit Projects GHGs						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007680	Preventive Maintenance	$3,323,160	Qualitative		No assumed impact/ negligible impact on emissions	$3,323,160
RTD0007681	Non-Fixed Route ADA Pa-ra Serv	$1,653,255	Qualitative		No assumed impact/ negligible impact on emissions	$1,653,255
RTD0007682	Short Range Transit Plan-ning	$100,000	Qualitative		No assumed impact/ negligible impact on emissions	$100,000
RTD0007683	Operating Assistance	$861,550	Qualitative		No assumed impact/ negligible impact on emissions	$861,550
RTD0007687	Replace 3 Model Yr 2007 buses delivery 2020	$1,377,150	Quantified	8,166	Quantified Decrease in Emissions from Bus Replacement	$1,377,150

2020 Merrimack Valley Region Transit Projects GHGs (Cont.)						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007695	SGR Riverbank stabilization Construction	$1,750,330	Qualitative		No assumed impact/ negligible impact on emissions	$1,750,330
RDT0007696	SGR Replace 1 model year 2013 supervisory vehicle	$46,530	Qualitative		No assumed impact/ negligible impact on emissions	$46,530

2021 Merrimack Valley Region Transit Projects GHGs						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007684	Preventive Maintenance	$3,495,970	Qualitative		No assumed impact/ negligible impact on emissions	$3,495,970
RTD0007685	Non-Fixed Route ADA Para Serv	$1,741,065	Qualitative		No assumed impact/ negligible impact on emissions	$1,741,065
RTD0007686	Short Range Transit Plan-ning	$100,000	Qualitative		No assumed impact/ negligible impact on emissions	$100,000
RTD0007688	Operating Assistance	$906,350	Qualitative		No assumed impact/ negligible impact on emissions	$906,350
RTD0007689	Replace 16 Model Yr 2015 vans with new	$1,180,480	Quantified	32,764	Quantified Decrease in Emissions from Bus Replacement	$1,180,480

2021 Merrimack Valley Region Transit Projects GHGs (Cont.)						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007697	SGR Replace 1 model yr 2014 supervisory vehicle	$47,900	Qualitative		No assumed impact/ negligible impact on emissions	$47,900

2022 Merrimack Valley Region Transit Projects GHGs						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007690	Preventive Maintenance	$3,611,335	Qualitative		No assumed impact/ negligible impact on emissions	$3,611,335
RTD0007691	Non-Fixed Route ADA Para Serv	$1,801,630	Qualitative		No assumed impact/ negligible impact on emissions	$1,801,630
RTD0007692	Short Range Transit Plan-ning	$100,000	Qualitative		No assumed impact/ negligible impact on emissions	$100,000
RTD0007693	Operating Assistance	$936,260	Qualitative		No assumed impact/ negligible impact on emissions	$936,260
RTD0007694	Replace Model Yr 2009 buses delivery 2022 7 of 9	$3,417,680	Quantified	19,755	Quantified Decrease in Emissions from Bus Replacement	$3,417,680

2022 Merrimack Valley Region Transit Projects GHGs (Cont.)						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0008061	SGR Replace 2 model year 2016 supervisory vehicles	$97,740	Qualitative		No assumed impact/ negligible impact on emissions	$97,740

2023 Merrimack Valley Region Transit Projects GHGs						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007698	Preventive Maintenance	$3,730,510	Qualitative		No assumed impact/ negligible impact on emissions	$3,730,510
RTD0007699	Operating Assistance	$967,150	Qualitative		No assumed impact/ negligible impact on emissions	$967,150
RTD0007700	Non-Fixed Route ADA Para Serv	$1,861,090	Qualitative		No assumed impact/ negligible impact on emissions	$1,861,090
RTD0007701	Replace 2 Model Yr 2009 buses delivery 2023	$1,005,780	Quantified	5,644	Quantified Decrease in Emissions from Bus Replacement	$1,005,780
RTD0007702	Replace 6 model yr 2017 vans delivery 2023	$469,620	Qualitative		Not yet enough infor-mation to calculate	$469,620

2023 Merrimack Valley Region Transit Projects GHGs (Cont.)						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
RTD0007703	Short Range Transit Plan-ning	$100,000	Qualitative		No assumed impact/ negligible impact on emissions	$100,000

2024 Merrimack Valley Region Transit Projects GHGs						
MassDOT/ FTA Project ID	**MassDOT/ FTA Project Description**	**Total Pro-grammed Funds**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Total Cost**
	Preventive Maintenance	$3,853,620	Qualitative		No assumed impact/ negligible impact on emissions	$3,853,620
	Non-Fixed Route ADA Para Serv	$1,922,630	Qualitative		No assumed impact/ negligible impact on emissions	$1,922,630
	Operating Assistance	$865,320	Qualitative		No assumed impact/ negligible impact on emissions	$865,320
	Short Range Transit Plan-ning	$100,000	Qualitative		No assumed impact/ negligible impact on emissions	$100,000
	SGR Replace 2 model year 2011 buses delivery 2024 2 of 8	$1,035,940	Qualitative		Not yet enough infor-mation to calculate	$1,035,940

Amesbury Reconstruction of Elm Street **CMAQ Air Quality Analysis**

CMAQ Air Quality Analysis Worksheet for Complete Streets Project

FILL IN SHADED BOXES ONLY

TIP YEAR: **2019**

MPO: **Merrimack Valley** **Municipality:** Amesbury

Project: **# 602418 Reconstruction of Elm Street**

Step 1: Calculate New Walk and Bike Miles Traveled:

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

				User Input (blank for default)	Default
A.	Facility Length **(L)**:	1.1	Miles		
B	Types of Improvements Implemented:	Both	(select Pedestrian, Bicycle, or Both)		
B.	Service Area Radius for Bicycling **(RB)**:	0.5	Miles		0.5
C.	Service Area Radius for Walking **(RW)**:	0.25	Miles		0.25
D.	Service Area of Community(ies) **for Bicycling (SAB)**: L * 2RB = SAB	1.13	Sq. Miles		
E.	Service Area of Community(ies) **for Walking (SAW)**: L * 2RW = SAW	0.565	Sq. Miles		
F.	Land Area of Neighborhoods Served **(AN)**: Popula-	11.2	Sq. Miles		
G.	tion of Neighborhoods Served **(PN)**:	7,137	Persons		
H.	Population Density of Neighborhoods Served **(PD)**:	637	Persons/Sq. Mile		
I.	Population Served by Facility for Bicycling **(PB)**: PD * SAB = PB	720	Persons		
J.	Population Served by Facility for Walking **(PW)**: PD * SAW = PW	360	Persons		
K.	Trips per Person per Day in Service Area **(T)**:	4.7	Trips		4.7
L.	Baseline Bicycle Mode Share in Service Area **(MSB)**:	0.6%	Percent		

Amesbury Reconstruction of Elm Street **CMAQ Air Quality Analysis (Cont.)**

M.	Baseline Walk Mode Share in Service Area **(MSW)**:	4.7%	Percent		
N.	Relative Increase in Service Area Bicycle Mode Share from Improvements **(BI)**:	30.0%	Percent		30.0%
O.	Relative Increase in Service Area Walk Mode Share from Improvements **(WI)**:	7.5%	Percent		7.5%
P.	New Bike Trips **(BT)**: PB * T * MSB * BI = BT	6	1-Way Trips/Day		
Q.	New Walk Trips **(WT)**: PW * T * MSW * WI = WT	6	1-Way Trips/Day		
R.	Average Bike Trip Length (**LB**):	2.3	Miles		2.3
S.	Average Walk Trip Length (**LW**):	0.7	Miles		0.7
T.	New Bike and Walk Miles of Travel **(BWM)**:	18	Miles per Day		
	Step 2: Calculate the VMT Reduction:				
U.	Prior Drive Mode Share of New Bike and Walk Trips **(MSD)**:	59.0%	Percent	59%	
V.	VMT Reduced per Day **(VMTR)**: BWM * MSD = VMTR	11	Miles per Day		
W.	VMTR * Operating Days Per Year 16 * 365 =	3,942	VMTR Per Year		
	If the Vehicle Miles Traveled Reduction is known enter in the box to the right.		VMTR Per Year		
	Note: A manual entry of the VMTR will override the calculated cell.				

Step 3: MOVES 2014a Emission Factors for Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH Eastern

2020 Passenger Summer VOC Factor grams/mile	2020 Passenger Summer NOx Factor grams/mile	2020 Passenger Summer CO Factor grams/mile	2020 Passenger Summer CO2 Factor grams/mile
0.030	**0.081**	**2.095**	**338.769**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
0.1	**0.3**	**8.4**	**1,335.5**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,000,000	/	0.1	=	**$8,355,241**
Summer NOx	$1,000,000	/	0.3	=	**$3,058,798**
Summer CO	$1,000,000	/	8.4	=	**$118,866**
Summer CO2	$1,000,000	/	1,335.5	=	**$749**

Spreadsheet Template Prepared by Office of Transportation Planning Updated March 2016

Georgetown - Boxford Border-to-Boston Trail **CMAQ Air Quality Worksheet**

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

FILL IN SHADED BOXES ONLY

TIP YEAR: **2019**

MPO: **Merrimack Valley** **Municipality: Georgetown, Boxford**

Project: **# 607541 Georgetown-Boxford Border to Boston Trail**

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	2.0	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles Sq.	(Default = 1)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	4	Miles Sq.	
D.	Total Land Area of Community(ies) **(T)**:	36.5	Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	11.0%		
F.	Total Population of Community(ies) **(TP)**: Popu-	16,579	Persons	
G.	lation Served by Facility **(P)**: LA * TP = P	1,817	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	5,828	HH HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	639	Persons	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	8,647	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH Work-	1.48	Persons	
L.	ers in Service Area **(WSA)**: HS * WPHH = WSA	948		
M.	Population Density of the Service area **(PD)**: P / SA = PD	454	Persons Per Sq. Mile	

Georgetown - Boxford Border-to-Boston Trail **CMAQ Air Quality Worksheet (Cont.)**

N. If the bicycle and pedestrian commuter mode share is known, enter the percentage at the right. **(BMS)** 0.8%

If not, use US Census - American Community Survey data to determine the mode share and enter the percentage.
http://www.census.gov/programs-surveys/acs/guidance/estimates.html

O. Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT 7 One-Way Trips

P. Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT 12 One-Way Trips

(Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)

Step 2: Calculate the VMT Reduction Per Day:

A. ((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR 39.4 VMTR Per Day

B. VMTR * Operating Days Per Year 39.4 * 200 = 7,872 VMTR Per Year

If the Vehicle Miles Traveled Reduction is known enter in the box to the right. VMTR Per Year

Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOVES 2014a Emission Factors for Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH Eastern

2020 Passenger Summer VOC Factor grams/mile	2020 Passenger Summer NOx Factor grams/mile	2020 Passenger Summer CO Factor grams/mile	2020 Passenger Summer CO2 Factor grams/mile
0.030	**0.081**	**2.095**	**338.769**

Georgetown - Boxford Border-to-Boston Trail **CMAQ Air Quality Worksheet (Cont.)**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
0.2	**0.7**	**16.8**	**2,666.9**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,874,028	/	0.2	=	**$7,840,800**
Summer NOx	$1,874,028	/	0.7	=	**$2,870,465**
Summer CO	$1,874,028	/	16.8	=	**$111,547**
Summer CO2	$1,874,028	/	2,666.9	=	**$703**

Spreadsheet Template Prepared by Office of Transportation Planning Updated March 2016

Georgetown - Newbury Border to Boston Trail **CMAQ Air Quality Worksheet**

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

FILL IN SHADED BOXES ONLY

TIP YEAR: **2020**

MPO: **Merrimack Valley** **Municipality: Georgetown, Newbury**

Project: **# 607542 Georgetown-Newbury Border to Boston Trail**

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	3.6	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles Sq.	(Default = 1)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	7.2	Miles Sq.	
D.	Total Land Area of Community(ies) **(T)**:	36.3	Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	19.8%		
F.	Total Population of Community(ies) **(TP)**: Popu-	15,088	Persons	
G.	lation Served by Facility **(P)**: LA * TP = P	2,993	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	5,808	HH HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	1,152	Persons	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	8,055	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH Work-	1.39	Persons	
L.	ers in Service Area **(WSA)**: HS * WPHH = WSA	1,598		
M.	Population Density of the Service area **(PD)**: P / SA = PD	416	Persons Per Sq. Mile	

Georgetown - Newbury Border to Boston Trail **CMAQ Air Quality Worksheet (Cont.)**

N. If the bicycle and pedestrian commuter mode share is known, enter the percentage at the ri **(BMS)** 1.5%
If not, use US Census - American Community Survey data to determine the mode share and enter the percentage.
http://www.census.gov/programs-surveys/acs/guidance/estimates.html

O. Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT 24 One-Way Trips

P. Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT 40 One-Way Trips
(Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)

Step 2: Calculate the VMT Reduction Per Day:

A. ((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR 231.5 VMTR Per Day

B. VMTR * Operating Days Per Year 231.5 * 200 = 46,290 VMTR Per Year
If the Vehicle Miles Traveled Reduction is known enter in the box to the right. VMTR Per Year
Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOVES 2014a Emission Factors for Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH Eastern

2020 Passenger Summer VOC Factor grams/mile	2020 Passenger Summer NOx Factor grams/mile	2020 Passenger Summer CO Factor grams/mile	2020 Passenger Summer CO2 Factor grams/mile
0.030	**0.081**	**2.095**	**338.769**

Georgetown - Newbury Border to Boston Trail **CMAQ Air Quality Worksheet (Cont.)**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
1.4	**3.8**	**98.8**	**15,681.6**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$4,341,120	/	1.4	=	**$3,088,934**
Summer NOx	$4,341,120	/	3.8	=	**$1,130,838**
Summer CO	$4,341,120	/	98.8	=	**$43,945**
Summer CO2	$4,341,120	/	15,681.6	=	**$277**

Spreadsheet Template Prepared by Office of Transportation Planning Updated March 2016

Groveland Community Trail Project # 608298 **CMAQ Air Quality Worksheet**

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

FILL IN SHADED BOXES ONLY

TIP YEAR: **2020**

MPO: **Merrimack Valley** **Municipality:** Groveland

Project: **Groveland Community Trail Project # 608298**

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	2.2	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles Sq.	(Default = 1)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	4.4	Miles Sq.	
D.	Total Land Area of Community(ies) **(T)**:	8.9	Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	49.4%		
F.	Total Population of Community(ies) **(TP)**:	6,646	Persons	
G.	Population Served by Facility **(P)**: LA * TP = P	3,286	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	2,385	HH HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	1,179	Persons	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	3,405	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH	1.43	Persons	
L.	Workers in Service Area **(WSA)**: HS * WPHH = WSA	1,683		
M.	Population Density of the Service area **(PD)**: P / SA = PD	747	Persons Per Sq. Mile	

Groveland Community Trail Project # 608298 **CMAQ Air Quality Worksheet (Cont.)**

N. If the bicycle and pedestrian commuter mode share is known, enter the percentage at the righ **(BMS)** 0.4%

If not, use US Census - American Community Survey data to determine the mode share and enter the percentage.
http://www.census.gov/programs-surveys/acs/guidance/estimates.html

O. Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT 7 One-Way Trips

P. Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT 11 One-Way Trips

(Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)

Step 2: Calculate the VMT Reduction Per Day:

A. ((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR 40.0 VMTR Per Day

B. VMTR * Operating Days Per Year 40.0 * 200 = 7,999 VMTR Per Year

If the Vehicle Miles Traveled Reduction is known enter in the box to the right. VMTR Per Year

Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOVES 2014a Emission Factors for Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH Eastern

2020 Passenger Summer VOC Factor grams/mile	2020 Passenger Summer NOx Factor grams/mile	2020 Passenger Summer CO Factor grams/mile	2020 Passenger Summer CO2 Factor grams/mile
0.030	**0.081**	**2.095**	**338.769**

Groveland Community Trail Project # 608298 **CMAQ Air Quality Worksheet (Cont.)**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
0.2	**0.7**	**17.1**	**2,709.9**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$2,672,677	/	0.2	=	**$11,004,874**
Summer NOx	$2,672,677	/	0.7	=	**$4,028,811**
Summer CO	$2,672,677	/	17.1	=	**$156,560**
Summer CO2	$2,672,677	/	2,709.9	=	**$986**

Spreadsheet Template Prepared by Office of Transportation Planning Updated March 2016

Haverhill Bradford Rail Trail Extension from Route 125 to Railroad St. **CMAQ Air Quality Analysis**

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

FILL IN SHADED BOXES ONLY

TIP YEAR: **2019**

MPO: **Merrimack Valley** **Municipality:** **Haverhill**

Project: **# 608027 Bradford Rail Trail Extension from Route 125 to Railroad Street**

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	0.2	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles Sq.	(Default = 1)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	0.4	Miles Sq.	
D.	Total Land Area of Community(ies) **(T)**:	33	Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	1.2%		
F.	Total Population of Community(ies) **(TP)**: Popu-	62,079	Persons	
G.	lation Served by Facility **(P)**: LA * TP = P	752	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	23,781	HH HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	288	Persons	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	30,696	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH Work-	1.29	Persons	
L.	ers in Service Area **(WSA)**: HS * WPHH = WSA	372		
M.	Population Density of the Service area **(PD)**: P / SA = PD	1,881	Persons Per Sq. Mile	

Haverhill Bradford Rail Trail Extension from Route 125 to Railroad St. **CMAQ Air Quality Analysis (Cont.)**

N. If the bicycle and pedestrian commuter mode share is known, enter the percentage at the ri **(BMS)** 3.1%
If not, use US Census - American Community Survey data to determine the mode share and enter the percentage.
http://www.census.gov/programs-surveys/acs/guidance/estimates.html

O. Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT 12 One-Way Trips

P. Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT 20 One-Way Trips
(Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)

Step 2: Calculate the VMT Reduction Per Day:

A. ((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR 6.2 VMTR Per Day

B. VMTR * Operating Days Per Year 6.2 * 200 = 1,246 VMTR Per Year
If the Vehicle Miles Traveled Reduction is known enter in the box to the right. VMTR Per Year
Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOVES 2014a Emission Factors for Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH Eastern

2020 Passenger Summer VOC Factor grams/mile	2020 Passenger Summer NOx Factor grams/mile	2020 Passenger Summer CO Factor grams/mile	2020 Passenger Summer CO2 Factor grams/mile
0.030	**0.081**	**2.095**	**338.769**

Haverhill Bradford Rail Trail Extension from Route 125 to Railroad St. **CMAQ Air Quality Analysis (Cont.)**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
0.0	**0.1**	**2.7**	**422.0**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$1,176,240	/	0.0	=	**$31,101,222**
Summer NOx	$1,176,240	/	0.1	=	**$11,385,951**
Summer CO	$1,176,240	/	2.7	=	**$442,461**
Summer CO2	$1,176,240	/	422.0	=	**$2,787**

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Haverhill - Intersection Reconstruction on Route 108 at Route 110 **CMAQ Air Quality Analysis Worksheet**

CMAQ Air Quality Analysis Worksheet for Traffic Flow and Intersection Improvements

FILL IN SHADED BOXES ONLY

TIP YEAR **2021**

MPO: **Merrimack Valley** **Municipality:** **Haverhill**

Project: **# 608761 Intersection Reconstruction on Route 108 (Newton Road) at Roiute 110 (Kenoza Av & Amesbury Rd)**

Step 1: Calculate Existing AM Peak Hour Total Intersection Delay in Seconds:

Street Name	Dir	Left-Turns (Vol / PHF)	X delay per veh	=	Total move. delay	+	Thru (Vol / PHF)	X delay per veh	=	Total move. delay	+	Right-Turns (Vol / PHF)	X delay per veh	=	Total move. delay	=	Total approach delay
	NB	0 / 1.00	0.0	=	0	+	350 / 1.00	0.0	=	0	+	12 / 1.00	0.0	=	0	=	0
Rt 108	SB	0 / 1.00	0.0	=	0	+	610 / 1.00	0.0	=	0	+	114 / 1.00	0.0	=	0	=	0
Rt 110	EB	0 / 1.00	0.0	=	0	+	411 / 1.00	0.0	=	0	+	185 / 1.00	0.0	=	0	=	0
Rt 110	WB	0 / 1.00	0.0	=	0	+	458 / 1.00	0.0	=	0	+	21 / 1.00	0.0	=	0	=	0
																Total Intersection Delay/Seconds =	**0**

Haverhill - Intersection Reconstruction on Route 108 at Route 110 **CMAQ Air Quality Analysis Worksheet (Cont.)**

Step 2: Calculate Existing PM Peak Hour Total Intersection Delay in Seconds:

Street Name	Dir	Left-Turns (Vol / PHF)		X delay per veh	=	Total move. delay	+ Thru (Vol / PHF)		X delay per veh	=	Total move. delay	+ Right-Turns (Vol / PHF)		X delay per veh	=	Total move. delay	=	Total approach delay
	NB		1.00		=	0	+ 0	1.00		=	0	+	1.00		=	0	=	0
Rt 108	SB	40	1.00	43.3	=	1,732	+ 0	1.00		=	0	+ 134	1.00	43.3	=	5,802	=	7,534
Rt 110	EB	253	1.00	9.7	=	2,454	+ 463	1.00	0.0	=	0	+ 0	1.00		=	0	=	2,454
Rt 110	WB	0	1.00		=	0	+ 421	1.00	0.0	=	0	+ 145	1.00	0.0	=	0	=	0
																Total Intersection Delay/Seconds	=	**9,988**

Step 3: The spreadsheet automatically chooses the peak hour with the longer total intersection delay for the next step in the analysis.

Peak Hour: PM Total Intersection Delay: 9,988

Step 4: Calculate the existin PM Peak Hour Total Intersection Delay with Improvements:

Street Name	Dir	Left-Turns (Vol / PHF)		X delay per veh	=	Total move. delay	+ Thru (Vol / PHF)		X delay per veh	=	Total move. delay	+ Right-Turns (Vol / PHF)		X delay per veh	=	Total move. delay	=	Total approach delay
	NB		1.00		=	0	+	1.00		=	0	+	1.00		=	0	=	0
Rt 108	SB	40	1.00	60.6	=	2,424	+ 0	1.00		=	0	+ 134	1.00	13.1	=	1,755	=	4,179
Rt 110	EB	253	1.00	9.7	=	2,454	+ 463	1.00		=	0	+ 0	1.00		=	0	=	2,454
Rt 110	WB	0	1.00		=	0	+ 421	1.00		=	0	+ 145	1.00		=	0	=	0
																Total Intersection Delay/Seconds	=	**6,634**

Haverhill - Intersection Reconstruction on Route 108 at Route 110 **CMAQ Air Quality Analysis Worksheet (Cont.)**

Step 5: Calculate vehicle delay in hours per day:

	(	Delay in seconds	X	Hours per day)	/	Seconds per hour	=	Delay in hours / day
Existing peak hour intersection delay	(	9,988	X	10)	/	3600	=	27.7
Peak hour intersection delay w/ improvements	(	6,634	X	10)	/	3600	=	18.4

Step 6: MOVES 2014a emission factors for idling speed: AM or PM **PM**

2020 Summer VOC Factor grams/hour	2020 Summer NOx Factor grams/hour	2020 Winter CO Factor grams/hour	2020 Summer CO2 Factor grams/hour
0.249	**0.630**	**3.569**	**3565.610**

Step 7: Calculate net emissions change in kilograms per day:

	Delay in Hours per Day	Summer VOC Emissions kilograms/day	Summer NOx Emissions kilograms/day	Winter CO Emissions kilograms/day	Summer CO2 Emissions kilograms/da
Existing Conditions	27.7	0.007	0.017	0.099	98.929
With Improvements	18.4	0.005	0.012	0.066	65.701
Net Change		**-0.002**	**-0.006**	**-0.033**	**-33.228**

Step 8: Calculate net emissions change in kilograms per year (seasonally adjusted)

	Net change per day (kg)		Avg. weekdays per year		Seasonal adj. factor		Adj. net change in kg per year
Summer VOC Emissions	-0.002	X	250	X	1.0188	=	**-0.591**
Summer NOx Emissions	-0.006	X	250	X	1.0188	=	**-1.494**
Winter CO Emissions	-0.033	X	250	X	0.9812	=	**-8.158**
Summer CO2 Emissions	-33.228	X	250	X	1.000		**-8,306.881**

Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Adj. net change in kg per year		First year cost per kilogram
Summer VOC	$1,944,000	/	-0.591	=	**3,291,034**
Summer NOx	$1,944,000	/	-1.494	=	**1,300,809**
Winter CO	$1,944,000	/	-8.158	=	**238,286**
Summer CO2	$1,944,000	/	-8,306.881	=	**234**

Spreadsheet Template Prepared by Office of Transportation Planning Updated March 2016

Lawrence Manchester Rail Corridor Rail Trail **CMAQ Air Quality Worksheet**

CMAQ Air Quality Analysis Worksheet for Bicycle and Pedestrian Project

FILL IN SHADED BOXES ONLY

TIP YEAR: **2023**

MPO: **Merrimack Valley** **Municipality:** Lawrence

Project: **Lawrence Manchester Rail Corridor (LMRC) Rail Trail Project # 608930**

Step 1: Calculate Estimated Reduction in Vehicle Miles Traveled (VMT):

If VMT reduction per year is known then go to Step 2B, if not proceed with Step 1 :

A.	Facility Length **(L)**:	1.5	Miles	
B.	Service Area Radius **(R)**:	1.0	Miles Sq.	(Default = 1)
C.	Service Area of Community(ies) **(SA)**: L * 2R = SA	2.92	Miles Sq.	
D.	Total Land Area of Community(ies) **(T)**:	6.93	Miles	
E.	Service Area % of Community(ies) Land Area **(LA)**: SA / T = LA	42.1%		
F.	Total Population of Community(ies) **(TP)**:	79,337	Persons	
G.	Population Served by Facility **(P)**: LA * TP = P	33,429	Persons	
H.	Total Number of Households in Community(ies) **(HH)**:	25,759	HH HH	
I.	Number of Households Served by Facility **(HS)**: LA * HH = HS	10,854	Persons	
J.	Total Number of Workers Residing in Community(ies) **(W)**:	33,261	Persons	
K.	Workers Per household **(WPHH)**: W / HH = WPHH	1.29	Persons	
L.	Workers in Service Area **(WSA)**: HS * WPHH = WSA	14,015		
M.	Population Density of the Service area **(PD)**: P / SA = PD	11,448	Persons Per Sq. Mile	

Lawrence Manchester Rail Corridor Rail Trail **CMAQ Air Quality Worksheet (Cont.)**

N. If the bicycle and pedestrian commuter mode share is known, enter the percentage at the right **(BMS)** 4.7%

If not, use US Census - American Community Survey data to determine the mode share and enter the percentage.
http://www.census.gov/programs-surveys/acs/guidance/estimates.html

O. Bike and Ped. Work Utilitarian Trips **(BWT)**: WSA * BMS = BWT 659 One-Way Trips

P. Bike and Ped. Non-Work Utilitarian Trips **(BNWT)**: BWT * 1.7 = BNWT 1,120 One-Way Trips

(Latest planning assumptions estimate non-work utilitarian trips to be 1.7 times the work utilitarian.)

Step 2: Calculate the VMT Reduction Per Day:

A. ((2 * BWT) + (2 * BNWT)) * (0.5* L) = VMTR 2596.6 VMTR Per Day

B. VMTR * Operating Days Per Year 2,596.6 * 200 = 519,313 VMTR Per Year

If the Vehicle Miles Traveled Reduction is known enter in the box to the right. VMTR Per Year

Note: A manual entry of the VMTR will override the calculated cell.

Step 3: MOVES 2014a Emission Factors for Unrestricted PM:

Note: Use 35 MPH as a default if average speed is not known. Speed Used: 35 MPH Eastern

2020 Passenger Summer VOC Factor grams/mile	2020 Passenger Summer NOx Factor grams/mile	2020 Passenger Summer CO Factor grams/mile	2020 Passenger Summer CO2 Factor grams/mile
0.030	**0.081**	**2.095**	**338.769**

Lawrence Manchester Rail Corridor Rail Trail **CMAQ Air Quality Worksheet (Cont.)**

Step 4: Calculate emissions reductions in kilograms per year (Seasonally Adjusted):

Summer VOC	Summer NOx	Summer CO	Summer CO2
15.8	**43.1**	**1,108.2**	**175,927.3**

Step 5: Calculate cost effectiveness (first year cost per kg of emissions reduced)

Emission	Project Cost		Emission Reduction in kg per year		First year cost per kilogram
Summer VOC	$14,895,375	/	15.8	=	**$944,750**
Summer NOx	$14,895,375	/	43.1	=	**$345,867**
Summer CO	$14,895,375	/	1,108.2	=	**$13,440**
Summer CO2	$14,895,375	/	175,927.3	=	**$85**

Spreadsheet Template Prepared by Office of Transportation Planning Updated March 2016

Merrimack Valley RTA Replace 3 (2007) Buses with 3 (2020) Buses

CMAQ Bus Replacement Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: **2020** **Bus Replacements**

MPO: **Merrimack Valley**

RTA: **Merrimack Valley**

Project #RTD0006781 - Replace 3 (2007) Buses with 3 (2020) Buses

Emission Rates in grams/mile at assumed operating speed bin of: 18 MPH (Bin 5 (17.5-22.5))

Scenario Comparison		Model Year	**Summer VOC** (grams/mile)	**Summer NOx** (grams/mile)	**Winter CO** (grams/mile)	**Summer CO2** (grams/mile)
Existing Model*	=	2007	0.115	3.750	0.659	1,200.600
New Bus Purchase**	=	2020	0.048	0.764	0.275	1,133.23

* Please contact OTP for assistance on Existing Model emission factors

** MOVES 2014a Commercial Emission Factors - Please Specify the Following:

AM or PM:	PM	Restricted or Unrestricte	Unrestricted

Change (Buy-Base)	-0.067	-2.986	-0.384	-67.370

Calculate fleet vehicle miles per day:

Revenue miles per year	X	Deadhead factor	= fleet miles per year	\ operating days per year	= fleet miles per day
104,490		1.16	121,208	**354**	342

Merrimack Valley RTA Replace 3 (2007) Buses with 3 (2020) Buses (Cont.)

Calculate emissions change in kilograms per summer day

Change	rate change grams/mile	/ 1000 g/kg	X fleet miles per day	X seasonal adj factor	= change/day in kg
Change in Summer VOC	-0.067	1,000	342	1.0188	**-0.023**
Change in Summer NOx	-2.986	1,000	342	1.0188	**-1.042**
Change in Winter CO	-0.384	1,000	342	0.9812	**-0.129**
Change in Summer CO2	-67.370	1,000	342	1.0000	**-23.067**

Calculate emissions change in kilograms per year

Pollutant	= change/day in kg	X op.days per year	= change per year in kg
Summer VOC	-0.023	354	-8.274
Summer NOx	-1.042	354	-368.733
Winter CO	-0.129	354	-45.669
Summer CO2	-23.067	354	-8165.810

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC	**$1,377,150**	**12**	8.274	**$13,871**
Summer NOx	**$1,377,150**	**12**	368.733	**$311**
Winter CO	**$1,377,150**	**12**	45.669	**$2,513**
Summer CO2	**$1,377,150**	**12**	8165.810	**$14**

Template prepared by the Office of Transportation Planning Updated March 2016

Merrimack Valley RTA Replace 16 (2015) Vans with 16 (2021) Vans

CMAQ Bus Replacement Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: **2021** **Bus Replacements**

MPO: **Merrimack Valley**

RTA: **Merrimack Valley**

Project #RTD0006784 - Replace 16 (2015) Vans with 16 (2021) vans

Emission Rates in grams/mile at assumed operating speed bin of: 18 MPH (Bin 5 (17.5-22.5))

Scenario Comparison		Model Year	**Summer VOC** (grams/mile)	**Summer NOx** (grams/mile)	**Winter CO** (grams/mile)	**Summer CO2** (grams/mile)
Existing Model*	=	2015	0.008	0.058	2.014	501.185
New Bus Purchase**	=	2021	0.003	0.025	0.593	435.854

* Please contact OTP for assistance on Existing Model emission factors

** MOVES 2014a Commercial Emission Factors - Please Specify the Following:

AM or PM: PM

Restricted or Unrestricted: Unrestricted

Change (Buy-Base)	-0.005	-0.033	-1.421	-65.331

Calculate fleet vehicle miles per day:

Revenue miles per year	X	Deadhead factor	= fleet miles per year	operating days per year	= fleet miles per day
436,096		1.15	501,510	**359**	1,397

Merrimack Valley RTA Replace 16 (2015) Vans with 16 (2021) Vans (Cont.)

Calculate emissions change in kilograms per summer day

Change	rate change grams/mile	/ 1000 g/kg	X fleet miles per day	X seasonal adj factor	= change/day in kg
Change in Summer VOC	-0.005	1,000	1,397	1.0188	**-0.007**
Change in Summer NOx	-0.033	1,000	1,397	1.0188	**-0.047**
Change in Winter CO	-1.421	1,000	1,397	0.9812	**-1.948**
Change in Summer CO2	-65.331	1,000	1,397	1.0000	**-91.265**

Calculate emissions change in kilograms per year

Pollutant	= change/day in kg	X op.days per year	= change per year in kg
Summer VOC	-0.007	359	-2.555
Summer NOx	-0.047	359	-16.861
Winter CO	-1.948	359	-699.249
Summer CO2	-91.265	359	-32764.176

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC	**$1,185,310**	**4**	2.555	**$115,993**
Summer NOx	**$1,185,310**	**4**	16.861	**$17,575**
Winter CO	**$1,185,310**	**4**	699.249	**$424**
Summer CO2	**$1,185,310**	**4**	32764.176	**$9**

Template prepared by the Office of Transportation Planning Updated March 2016

Merrimack Valley RTA Replace 7 (2009) Buses with 7 (2022) Buses

CMAQ Bus Replacement Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: **2022** **Bus Replacements**

MPO: **Merrimack Valley**

RTA: **Merrimack Valley**

Project #RTD0006791 - Replace 7 (2009) Buses with 7 (2022) Buses

Emission Rates in grams/mile at assumed operating speed bin of: 18 MPH (Bin 5 (17.5-22.5))

Scenario Comparison		Model Year	**Summer VOC** (grams/mile)	**Summer NOx** (grams/mile)	**Winter CO** (grams/mile)	**Summer CO2** (grams/mile)
Existing Model*	=	2009	0.115	3.750	0.659	1,203.080
New Bus Purchase**	=	2022	0.048	0.764	0.275	1,133.23

* Please contact OTP for assistance on Existing Model emission factors

** MOVES 2014a Commercial Emission Factors - Please Specify the Following:

AM or PM: PM Restricted or Unrestricted: Unrestricted

Change (Buy-Base)	-0.067	-2.986	-0.384	-69.850

Calculate fleet vehicle miles per day:

Revenue miles per year	X Deadhead factor	= fleet miles per year	/ operating days per year	= fleet miles per day
243,810	1.16	282,820	**354**	799

Merrimack Valley RTA Replace 7 (2009) Buses with 7 (2022) Buses (Cont.)

Calculate emissions change in kilograms per summer day

Change	rate change grams/mile	/ 1000 g/kg	X fleet miles per day	X seasonal adj factor	= change/day in kg
Change in Summer VOC	-0.067	1,000	799	1.0188	**-0.055**
Change in Summer NOx	-2.986	1,000	799	1.0188	**-2.430**
Change in Winter CO	-0.384	1,000	799	0.9812	**-0.301**
Change in Summer CO2	-69.850	1,000	799	1.0000	**-55.805**

Calculate emissions change in kilograms per year

Pollutant	= change/day in kg	X op.days per year	= change per year in kg
Summer VOC	-0.055	354	-19.305
Summer NOx	-2.430	354	-860.376
Winter CO	-0.301	354	-106.561
Summer CO2	-55.805	354	-19754.949

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC	**$3,309,565**	**12**	19.305	**$14,286**
Summer NOx	**$3,309,565**	**12**	860.376	**$321**
Winter CO	**$3,309,565**	**12**	106.561	**$2,588**
Summer CO2	**$3,309,565**	**12**	19754.949	**$14**

Template prepared by the Office of Transportation Planning Updated March 2016

Merrimack Valley RTA Replace 2 (2009) Buses with 2 (2023) Buses

CMAQ Bus Replacement Air Quality Analysis Worksheet

FILL IN SHADED BOXES ONLY

TIP YEAR: **2023** **Bus Replacements**

MPO: **Merrimack Valley**

RTA: **Merrimack Valley**

Project #RTD0007135 - Replace 2 (2009) Buses with 2 (2023) Buses

Emission Rates in grams/mile at assumed operating speed bin of: 18MPH(Bin5(17.5-22.5))

Scenario Comparison		Model Year	**Summer VOC** (grams/mile)	**Summer NOx** (grams/mile)	**Winter CO** (grams/mile)	**Summer CO2** (grams/mile)
Existing Model*	=	2009	0.115	3.750	0.659	1,203.080
New Bus Purchase**	=	2023	0.048	0.764	0.275	1,133.23

* Please contact OTP for assistance on Existing Model emission factors

** MOVES 2014a Commercial Emission Factors - Please Specify the Following:

AM or PM: PM Restricted or Unrestricted: Unrestricted

Change (Buy-Base)	-0.067	-2.986	-0.384	-69.850

Calculate fleet vehicle miles per day:

Revenue miles per year	X	Deadhead factor	= fleet miles per year	/ operating days per year	= fleet miles per day
69,660		1.16	80,806	**354**	228

Merrimack Valley RTA Replace 2 (2009) Buses with 2 (2023) Buses (Cont.)

Calculate emissions change in kilograms per summer day

Change	rate change grams/mile	/ 1000 g/kg	X fleet miles per day	X seasonal adj factor	= change/day in kg
Change in Summer VOC	-0.067	1,000	228	1.0188	**-0.016**
Change in Summer NOx	-2.986	1,000	228	1.0188	**-0.694**
Change in Winter CO	-0.384	1,000	228	0.9812	**-0.086**
Change in Summer CO2	-69.850	1,000	228	1.0000	**-15.944**

Calculate emissions change in kilograms per year

Pollutant	= change/day in kg	X op.days per year	= change per year in kg
Summer VOC	-0.016	354	-5.516
Summer NOx	-0.694	354	-245.822
Winter CO	-0.086	354	-30.446
Summer CO2	-15.944	354	-5644.271

Calculate cost effectiveness (cost per kg of emissions reduced)

Pollutant	Total Project Cost	/ Project Life in years	/ reduction per year in kg	= annual cost per kg
Summer VOC	**$973,910**	**12**	5.516	**$14,714**
Summer NOx	**$973,910**	**12**	245.822	**$330**
Winter CO	**$973,910**	**12**	30.446	**$2,666**
Summer CO2	**$973,910**	**12**	5644.271	**$14**

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Appendix F Completed Highway and Transit Projects GHG Summary

Merrimack Valley Region MPO TIP Completed Highway Projects GHG Tracking Summary

Mass DOT/ Project ID	MassDOT Project Description	Total Pro-grammed Funds	GHG Analysis Type	GHG CO_2 Im-pact (kg/yr)	GHG Impact Description	Additional Description	Fiscal Year of Contract Award (2015 and forward)
606503	NEWBURYPORT CLIPPER CITY RAIL TRAIL ALONG THE CITY BRANCH (PHASE II)	$4,061,158	Quantified	34,996	Quantified Decrease in Emissions from Bicycle and Pedestrian Infra-structure	Advertised 9/19/2015 Notice to Proceed 4/1/2016	2016
606161	HAVERHILL-IMPROVEMENTS ON MAIN STREET (ROUTE 125)	$3,635,519	Quantified	16,491	Quantified Decrease in Emissions from Traffic Operational Improve-ment	Advertised 9/17/2016 Notice to Proceed 4/12/2017	2017
607573	HAVERHILL-RECONSTRUCTION ON ROUTE 97 (BROADWAY), FROM SILVER BIRCH LANE TO RESEARCH DRIVE	$6,526,912	Quantified	41,800	Quantified Decrease in Emissions from Traffic Operational Improve-ment	Advertised 5/13/2017 Notice to Proceed 2/9/2018	

Merrimack Valley Region MPO TIP Completed Highway Projects GHG Tracking Summary (Cont.)

Mass DOT/ Project ID	MassDOT Project Description	Total Pro-grammed Funds	GHG Analysis Type	GHG CO_2 Im-pact (kg/yr)	GHG Impact Description	Additional Description	Fiscal Year of Contract Award (2015 and forward)
604585	FLEX TO FTA FOR MVRTA NEW BUS UPGRADE TO CLEANER FUEL BUSES	$645,840	Quantified	26,343	Quantified Decrease in Emissions from Bus Replacement	Flexed to FTA	2017
605020	SALISBURY- MULTI-USE TRAIL EXTENSION (BORDERS TO BOSTON TRAIL), INCLUDES NEW BRIDGE S-02-004 AND BOARDWALK (S-02-012) (BYX)	$5,918,500	Quantified	18,631	Quantified Decrease in Emissions from Bicycle and Pedestrian Infra-structure	Advertised 8/25/2018 Contract Awarded 12/12/18 Notice to Proceed 1/18/19	2018

Merrimack Valley Region MPO TIP Completed Highway Projects GHG Tracking Summary (Cont.)

Mass DOT/ Project ID	MassDOT Project Description	Total Pro-grammed Funds	GHG Analysis Type	GHG CO_2 Impact (kg/yr)	GHG Impact Description	Additional Description	Fiscal Year of Contract Award (2015 and forward)
607737	AMESBURY- SALISBURY- TRAIL CONNECTOR @ I-95	$2,574,805	Quantified	3,972	Quantified Decrease in Emissions from Bicycle and Pedes-trian Infrastructure	Advertised 9/15/2018 Awaiting Contract Award	
606159	NORTH ANDOVER- INTERSECTION & SIGNAL IMPROVEMENTS AT ROUTE 125 & MASSACHUSETTS AVENUE	$5,446,662	Quantified	482,727	Quantified Decrease in Emissions from Traffic Operational Improvement	Advertised 1/12/2019 Bids due 4/17/2019	

Merrimack Valley Region MPO TIP Completed Transit Projects GHG Tracking Summary								
FTA Activity Line Item	**Transit Agency**	**Project Description**	**Total Cost**	**GHG Analysis Type**	**GHG CO_2 Impact (kg/yr)**	**GHG Impact Description**	**Additional Description**	**Fiscal Year Programmed (2015 and forward)**
	MVRTA	Purchase – Replacement Vans 11 Model Year 2009 Delivery 2015	$627,000	Quantified	41,814	Quantified Decrease in Emissions from Bus Replacement		2015
111202	MVRTA	Replace 10 of 17 Model Year 2004 Transit Buses with new buses (Delivery 2016)	$4,200,000	Quantified	12,557	Quantified Decrease in Emissions from Bus Replacement		2015
111215	MVRTA	Replace 5 Model Year 2011 Paratransit Vehicles (Delivery 2016)	$320,000	Quantified	15,992	Quantified Decrease in Emissions from Bus Replacement		2016
111202	MVRTA	Replace 7 MY 2004 Transit Buses with new buses	$2,989,000	Quantified	18,271	Quantified Decrease in Emissions from Bus Replacement		2017

Merrimack Valley Region MPO TIP Completed Transit Projects GHG Tracking Summary (Cont.)

FTA Activity Line Item	Transit Agency	Project Description	Total Cost	GHG Analysis Type	GHG CO_2 Impact (kg/yr)	GHG Impact Description	Additional Descrip-tion	Fiscal Year Pro-grammed (2015 and forward)
111202	MVRTA	Replace 6 Model Year 2004 Buses (Delivery 2018)	$2,689,500	Quantified	15,661	Quantified Decrease in Emissions from Bus Replacement		2018

Appendix G List of Acronyms

MVMPO List of Commonly Used Acronyms		
A	AADT	Average Annual Daily Traffic
	AASHTO	American Association of State Highway Transportation Officials
	ABP	MassDOT Accelerated Bridge Program
	AC	Advance Construction
	ADA	Americans with Disabilities Act (1990)
	ADT	Average Daily Traffic
	ARRA	American Recovery and Reinvestment Act (of 2009)
	AQ	Air Quality
B	B to B	Border to Boston Rail Trail
	BR, BR-On, BR-Off	Bridge Rehabilitation or Replacement (On- or Off-National Highway System)
C	(C)	Type of Project = Capital Improvement
	3C	Continuing, Comprehensive and Coordinated (Transportation Planning)
	CAAA	Clean Air Act Amendments of 1990
	CFR	Code of Federal Regulations
	CIP	Capital Investment Plan
	CLF	Conservation Law Foundation
	CMAQ	Congestion Mitigation and Air Quality Improvement Program
	CMP	Congestion Management Process
	CMR	Code of Massachusetts Regulations
	CNG	Compressed Natural Gas
	CO	Carbon Monoxide

D	DEP	Department of Environmental Protection
	DOT	Department of Transportation
	DPW	Department of Public Works
E	EB	Eastbound
	EIR	Environmental Impact Report
	EIS	Environmental Impact Statement
	EJ	Environmental Justice
	ENF	Environmental Notification Form
	E.O.	Executive Order (of the Governor of the Commonwealth)
	EPA	U.S. Environmental Protection Agency
F	FA	Federal-Aid
	FAPRO	Federal Aid Program Reimbursement Office
	FAST Act	Fixing America's Surface Transportation Act legislation signed into law December 4, 2015
	FHWA	Federal Highway Administration
	FTA	Federal Transit Administration
	FY	(State) Fiscal Year
	FFY	Federal Fiscal Year
G	GANs	Grant Anticipation Notes
	GHG	Greenhouse Gas
H	HPP	USDOT High Priority Project
	HSIP	Highway Safety Improvement Program

I	IM	Interstate Maintenance
	ITS	Intelligent Transportation System
	ISTEA	Intermodal Surface Transportation Efficiency Act of 1991
L	LEP	Limited English Proficiency
	LOS	Level of Service
	LTA	Local Technical Assistance
M	(M)	Type of project = Maintenance
	MAP-21	Moving Ahead for Progress in the 21st Century legislation signed into law July 6, 2012
	MassDOT	Massachusetts Department of Transportation
	MCAD	Massachusetts Commission Against Discrimination
	MEPA	Massachusetts Environmental Policy Act
	M.G.L.	Massachusetts General Laws
	MOA	Memorandum of Agreement
	MOD	Massachusetts Office on Disabilities
	MOU	Memorandum of Understanding
	MPO	Metropolitan Planning Organization
	MVMPO	Merrimack Valley Metropolitan Planning Organization
	MVPC	Merrimack Valley Planning Commission
	MVPGS	Merrimack Valley Priority Growth Strategy
	MVRTA	Merrimack Valley Regional Transit Authority
N	(N)	Type of project = other, not capital expense, or operating expense, but other such as planning or design

	NAAQS	National Ambient Air Quality Standards
	NARC	National Association of Regional Councils
	NB	Northbound
	NEPA	National Environmental Policy Act
	NFA	Non-Federal Aid
	NHS	National Highway System
	NMCOG	Northern Middlesex Council of Governments
	NOx	Nitrogen Oxide
	NPRM	Notice of Proposed Rulemaking (Federal Register)
O	(O)	Type of Project = Operating Expense
	O&M	Operations and Maintenance
P	PCI	Pavement Condition Index
	PDA	Priority Development Area
	PL	(Metropolitan) Planning Funds
	PMS	Pavement Management System
	PPP	Public Participation Plan
	PRC	(MassDOT) Project Review Committee
	PSAC	Project Selection Advisory Council
	PS&E	The Plans, Specifications and Estimate to be used by contractors to bid on construction proposals
R	RGGI	Regional Greenhouse Gas Initiative
	ROW	Right-of-Way
	RPA	Regional Planning Agency
	RPMS	Regional Pavement Management System
	RTA	Regional Transit Authority
	RTP	Regional Transit Plan

S	SAFETEA-LU	Safe, Accountable, Flexible, Efficient Transportation Equity Act: A Legacy for Users
	SB	Southbound
	SD	Structurally Deficient
	SGR	State of Good Repair
	SIP	State (Air Quality) Implementation Plan
	SOV	Single Occupancy Vehicle
	SPR	Statewide Planning and Research Funds
	STBG	Surface Transportation Block Grant Program
	STIP	Statewide Transportation Improvement Program
	STP	Surface Transportation Program
T	TA	Transportation Alternatives
	TAM	Transit Asset Management
	TAP	Transportation Alternatives Program
	TCSP	Transportation and Community System Preservation Grant Program
	TDM	Transportation Demand Management
	TEA-21	Transportation Equity Act for the 21st Century
	TEC	Transportation Project Evaluation Criteria
	TERM score	Transit Economic Requirements Model score used to rate transit facility conditions
	TIP	Transportation Improvement Program
	TMA	Transportation Management Area
	TMC	Turning Movement Count
	TOD	Transit-Oriented Development
	TRB	Transportation Research Board

U	ULB	Useful Life Benchmark
	UPWP	Unified Planning Work Program
	USDOT	U.S. Department of Transportation
V	V/C	Volume/Capacity Ratio
	VMT	Vehicle Miles Traveled
	VOC	Volatile Organic Compound
W	WB	Westbound

Massachusetts Executive Orders		
EO	526	Nondiscrimination, Diversity, Equal Employment Opportunity and Affirmative Action
EO	12898	Environmental Justice in Minority and Low-Income Populations, February 1994
EO	13166	Improving Access to Programs (and Services) for persons with limited English Proficiency

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Appendix H Key to Maps Showing Locations of Transportation Projects

Appendix H Key to Maps Showing Locations of Transportation Projects

Map Number	Project Number	City/Town	Project Description
1	602418	Amesbury	Amesbury – Reconstruction of Elm Street
2	606522	Andover	Andover- Bridge Rehabilitation, A-09-036, I-495 over St 28 (SB), A-09-037, I-495 over B&M and MBTA, A-09-041, I-495 over St 28 (NB)
3	607541	Georgetown-Boxford	Georgetown – Boxford Border to Boston Trail from Georgetown Road to West Main Street (Route 97)
3	607542	Georgetown-Newbury	Georgetown– Newbury Border to Boston Trail (Northern Georgetown to Byfield Section)
4	608298	Groveland	Groveland- Groveland Community Trail, from Main Street to King Street
5	608027	Haverhill	Haverhill- Bradford Rail Trail Extension, from Route 125 to Railroad Street
5	RTD - 7695	MVRTA	SGR Riverbank Stabilization Construction
5	605306	Haverhill	Haverhill – Bridge Replacement, H-12- 039, I-495 (NB & SB) over Merrimack River
5	605304	Haverhill	Haverhill- Bridge Replacement, H-12-007 & H-12-025, Bridge Street (SR 125) over Merrimack River and the Abandoned B&M RR (Proposed Bikeway)

Appendix H Key to Maps Showing Locations of Transportation Projects (Continued)

Map Number	Project Number	City/Town	Project Description
6	608761	Haverhill	Haverhill – Intersection Reconstruction on Route 108 (Newton Road) at Route 110 (Kenoza Avenue and Amesbury Road)
6	608788	Haverhill	Haverhill – Roadway Reconstruction on North Avenue, from Main Street (Route 125) to Plaistow NH
7	608930	Lawrence	Lawrence - Lawrence Manchester Rail Corridor (LMRC) Rail Trail
8	608494	Newbury / Newburyport / Salisbury	Resurfacing of Route 1
9	608095	North Andover	North Andover- Corridor Improvements on Route 114, between Route 125 (Andover Street) & Stop & Shop driveway
10	602202	Salisbury	Salisbury – Reconstruction of Route 1 (Lafayette Road)
11	TBD	Haverhill	Haverhill – Bridge Replacement, H-12-040, I-495 (NB & SB) over Merrimack River