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Development of a Transportation Air Quality Sketch Planning Tool for the El Paso Region

Prepared for the El Paso MPO

Prepared under a grant from the Texas Commission on Environmental Quality

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Texas A&M Transportation Institute

Environment and Air Quality Division

The preparation of this report was financed through grants from the State of Texas through the Texas Commission on Environmental Quality (TCEQ). The content, findings, opinions and conclusions are the work of the author(s) and do not necessarily represent findings, opinions or conclusions of the TCEQ.

ABOUT THIS REPORT

This work was performed by the Texas A&M Transportation Institute (TTI), for the El Paso Metropolitan Planning Organization (MPO), and was funded through a State and Local Air Quality Planning Program grant from the Texas Commission on Environmental Quality.

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DISCLAIMER

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EXECUTIVE SUMMARY

This project, *Development of a Transportation Air Quality Sketch Planning Tool for the El Paso Region*, was performed by the Texas A&M Transportation Institute for the El Paso Metropolitan Planning Organization (MPO). This work was performed as part of the Rider 8 (currently Rider 7) State and Local Air Quality Planning Program administered by the Texas Commission on Environmental Quality.

The overall goal of this project was to develop a sketch planning tool that can be used for estimating the emissions impacts of transportation strategies or plans, including those modeled in the regional travel demand model (TDM), and other strategies that may not be reflected in the TDM. The tool was developed in a spreadsheet-based format, as an MS-Excel® workbook. Visual Basic was used for applications programming to create the various functions of the tool, including automation of calculation processes and display of outputs.

The tool consists of two distinct modules: a TDM-based module that uses TDM outputs to estimate network emissions for different scenarios, and a non-TDM component that estimates emissions benefits of individual projects/strategies based on user inputs. Each module has built in emissions factors and computations that are used to produce the outputs. The built-in emissions factors are based on the EPA's Motor Vehicle Emissions Simulator (MOVES) model. The pollutants estimated by the tool include ozone precursors (oxides of nitrogen and volatile organic compounds) and other pollutants including particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide, and carbon dioxide.

The TDM-based module can be used for the evaluation of strategies or projects that are modeled as part of the regional TDM. In this case, TDM files can be loaded into the tool, which automatically extracts pertinent information for emissions estimation. The tool then uses built-in emissions factors (developed using the MOVES model, for the El Paso region) for estimating emissions at the link, traffic analysis zone, district, and network levels. This information will allow for an evaluation of directional changes or potential indication of emissions impacts for alternative scenarios modeled in the TDM. The TDM-based component of the sketch planning tool is distinct from transportation conformity analyses; it does not replicate the conformity process and should not be used for conformity and other regulatory purposes.

The non-TDM module includes individual emissions reduction strategies, with calculation methodologies consistent with the Texas Guide to Accepted Mobile Source Emissions Reduction Strategies and other established methods. The strategies included in this module include vehicle replacement strategies, idle reduction strategies, and bicycle and pedestrian facilities.

In conclusion, this project resulted in the development of a functional, spreadsheet-based tool and accompanying user guide that can be applied by the El Paso MPO for evaluating emissions impacts of transportation strategies for planning purposes. Further enhancements to the tool can include periodic updates to emissions factors, expansion of non-TDM strategies that are included in the tool, automated interfacing with geographic information systems, and implementation as a web-based version in the future.

TABLE OF CONTENTS

LIST OF FIGURES

LIST OF TABLES

1. INTRODUCTION

BACKGROUND AND OBJECTIVES

The Texas A&M Transportation Institute (TTI) is under contract with the El Paso Metropolitan Planning Organization (MPO) for the development of a *Transportation Air Quality Sketch Planning Tool for the El Paso Region*. This project was conducted as part of the El Paso MPO's Rider 8 (currently Rider 7) State and Local Air Quality Planning Program grant from the Texas Commission on Environmental Quality (TCEQ).

The overall goal of this project was to develop a spreadsheet-based sketch planning tool that can be used for estimating the emissions impacts of transportation planning strategies or projects. Evaluating emissions reductions from different transportation strategies or estimating network-level emission trends can support the El Paso MPO and its partner agencies as they work toward meeting regional air quality goals. This tool allows for the estimation of ozone precursors (oxides of nitrogen and volatile organic compounds), in direct support of the goals of the Rider 7 program. Additionally, the tool also supports the estimation of other pollutants such as particulate matter, carbon monoxide, and carbon dioxide.

The primary aim was to enable analysis of emissions impacts at the transportation network level (i.e., based on strategies or scenarios modeled through the El Paso region's Travel Demand Model [TDM]). However, it was envisioned that the tool will also allow for the analysis of selected programs and initiatives that were not modeled through the TDM, such as vehicle replacement or idle reduction initiatives.

In keeping with the project goal, the sketch planning tool was developed with two distinct components: a TDM-based component that uses TDM outputs to estimate network emissions for different scenarios, and a non-TDM component that can be applied for other strategies. This report summarizes the work performed and results achieved as part of this project.

PROJECT TIMELINE AND MILESTONES

The period of performance for this work was November 2014 to June 2016. Prior to initiation of work, a Quality Assurance Project Plan (QAPP) was developed, with approval of the QAPP received from TCEQ on February 12, 2015. Appendix A shows the finalized QAPP. TTI also maintained regular contact with the MPO during the course of this project, submitting periodic progress reports and providing informal updates to MPO staff. Formal progress meetings (conference calls) were also held in January 2015, October 2015, January 2016, and April 2016. A draft version of the sketch planning tool and a user guide for the tool was submitted to the MPO in May 2016, followed by a demonstration session held for MPO staff to provide an overview of the tool and its applications.

Relationship to Other Studies and Initiatives

The sketch planning tool developed as part of this project is a standalone tool that can be used by El Paso MPO staff. However, the overall approach and methodology are consistent with other transportation air quality projects performed by TTI's Environment and Air Quality Division for stakeholders in Texas, and supplements transportation air quality assistance provided to the El Paso MPO. TTI previously developed a public outreach website and calculator (available at http://cleanairforelpaso.org/) for the El Paso MPO. If desired, this tool can be showcased on that website platform and could also be converted into a web-based format in the future.

The TDM-based component of the sketch planning tool is distinct from transportation conformity analyses; it does not replicate the conformity process and should not be used for conformity and other regulatory purposes.

Transportation Air Quality Sketch Planning Tools

The term "sketch planning" is broadly applied to tools and methodologies that are used for simplified, aggregated analyses in the area of travel demand assessment, traffic analysis, and related emissions estimation processes. As defined by the Federal Highway Administration (FHWA), "sketch planning methodologies and tools produce general order-of-magnitude estimates of travel demand and traffic operations in response to transportation improvements" (1). Since the 1990 Clean Air Act Amendments resulted in an emphasis on evaluation of Transportation Control Measures (TCMs), sketch-planning tools have increasingly been applied to evaluate emissions benefits from various transportation strategies and control measures (2). In recent years, several of these tools and methodologies (including sketch planning approaches) have also been applied for estimating greenhouse gas emissions impacts of transportation scenarios, in addition to previous focus on criteria pollutant emissions. FHWA provides a compilation of various available tools for transportation air quality and greenhouse gas assessments (3,4) and a 2005 National Cooperative Highway Research Program (NCHRP) report outlines the state-of-practice in terms of predicting air quality effects of traffic flow improvements (5). The application of these tools range from regional analyses, such as the Environmental Protection Agency's (EPA's) Travel Efficiency Assessment Method (6), to applications for individual TCMs, such as the Atlanta Regional Council's Congestion Mitigation and Air Quality (CMAQ) calculator (7).

In Texas, the Texas *Guide to Accepted Mobile Source Emissions Reduction Strategies* (MOSERS Manual) is an established resource for practitioners that is applied for CMAQ analyses and for the evaluation of emissions reductions for various TCMs and transportation strategies (8).

The sketch planning tool developed as part of this study is customized to the El Paso region and was developed in accordance with the MPO's goals for the tool. Methodologies and approaches from existing tools and models were reviewed and applied to the tool where relevant and feasible.

2. DEVELOPMENT OF SKETCH PLANNING TOOL

OVERVIEW

As described previously, the tool was developed with two distinct components, a TDM-based module and a non-TDM module. The TDM-based module uses TDM outputs to estimate network emissions for different scenarios, while the non-TDM component has the capability to estimate emissions benefits of individual projects/strategies that are not usually modeled in the TDM. The tool was developed in a spreadsheet-based format, as an MS-Excel® workbook. The tool uses the built-in Visual Basic for applications programming to create the various functions of the tool, including automation of calculation processes and display of outputs. Figure 1 summarizes the key elements of each module.

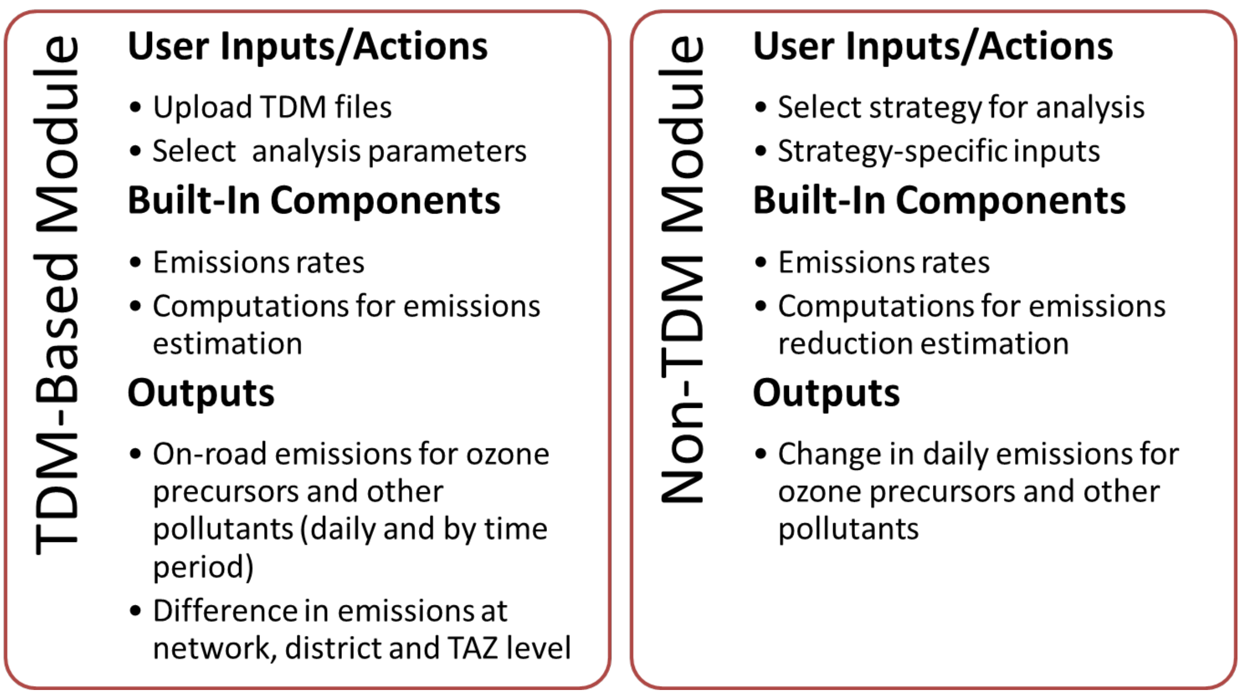

Figure 1. Overview of Sketch Planning Tool Modules

Each module requires specific user inputs/user selections and has built in emissions factors and computations that are used to produce the outputs. The built-in emissions factors are based on the EPA's Motor Vehicle Emissions Simulator (MOVES) model (i.e., MOVES 2014a). Common elements between the two modules include the analysis years that are built into the tool (corresponding to the current El Paso TDM conformity years of 2012, 2020, 2030, and 2040) and the pollutants that the tool is capable of estimating. The pollutants estimated by the tool include ozone precursors—oxides of nitrogen (NO_x) and volatile organic compounds (VOCs)—and other pollutants including particulate matter (PM_{10} and $PM_{2.5}$), carbon monoxide (CO), and carbon dioxide (CO_2). Following sections of this chapter describe the development of each module in further detail.

TDM-Based Module

Figure 2 shows a high-level overview of the TDM-based emissions estimation process. This module indicates directional changes in emissions for sketch planning purposes at the network-level, based on computed link-level emissions. As mentioned previously, this module is not meant to replicate the transportation conformity process. While the computational approach is broadly similar to a transportation conformity analysis, several simplifying assumptions have been made. The tool is therefore not to be used for conformity or other regulatory purposes, or to compare against other on-road emission inventories.

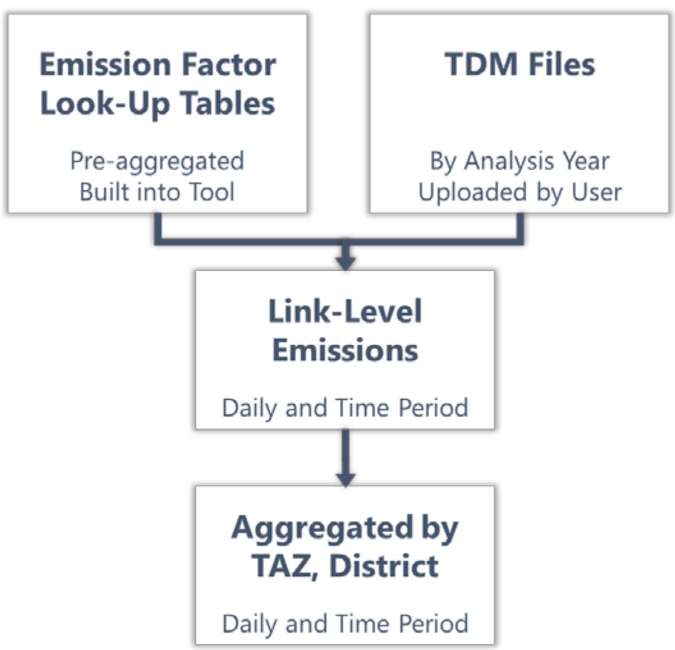

Figure 2. Overview of TDM-Based Emissions Estimation

The implementation of the TDM-based emissions estimation is based on the importing of TDM output files, to which built-in calculation methods are applied. Emissions factors lookup tables (EFLT) for selected analysis years are also used to apply emissions factors. The calculations result in link-level emissions estimates that are then aggregated to the traffic analysis zone (TAZ), district, and network levels. The outputs are in the form of graphical and tabular summaries, and the user can link the outputs using geographic information systems (GIS) for further mapping and spatial analyses.

Emissions Estimation Methodology

The emissions estimation methodology is comprised of four main elements, as detailed below:

1. **Pre-processing of TDM output files –** This step deals with extracting necessary columns from the TDM output. The TDM and its output includes over a 100 different characteristics (columns). Only a handful of this information is required for emissions estimation, primarily the link volume, link length, roadway type (functional class) and speed. In addition, key information necessary for spatial linking and aggregation of the data, such as the Link ID, TAZ, and District information are also extracted from the TDM files. The TDM base network file and the output (flow) files for the selected time periods of interest (AM peak, PM peak, midday, and overnight time periods) are required in order to pre-process and extract the necessary information.

2. **Development of EFLTs –** The tool utilizes emissions factors (emissions rates) aggregated for the four time periods, obtained from the MOVES model based on appropriate modeling inputs and parameters. The EFLTs include rates for summer and winter seasons, since summer is the time period of greater concern from an ozone precursor perspective, whereas winter is of importance in terms of criticality of CO and PM emissions. Appendix B provides further details on the development of the emissions factors for the lookup tables. In addition to the EFLTs for running emissions from MOVES, factors for estimation of $PM_{2.5}$ and PM_{10} emissions due to re-entrained dust were included based on EPA's AP-42 Compilation of Air Pollutant Emissions Factors.

3. **Adjustment of VMT** - Consistent with emissions inventory processes in Texas, adjustment factors are applied to convert VMT from the travel model from a mid-

week, non-summer season VMT to a representative of a summer or winter VMT. Further, an additional adjustment factor is applied to adjust the modeled VMT to be consistent with the Highway Performance Monitoring System (HPMS) data that is report statewide. This HPMS adjustment is also based on the EPA's guidance for emissions inventory development.

4. **Emission estimation and aggregation –** This step involves applying the appropriate MOVES emission rates from the EFLTs based on speed and roadway type to each roadway link, and multiplying by the adjusted VMT to obtain a link-level running emissions estimate. To calculate emissions factors for average operational speeds falling between two of the MOVES speed bin speeds, emissions factors are interpolated using established procedures. Appendix C describes the emissions estimation process and interpolation of emissions factors in further detail. For estimation of the suspended dust portion of the emissions for $PM_{2.5}$ and PM_{10}, the AP-42 emission factors are also applied to the VMT at the link level. A conversion factor is then applied to the running emissions component to estimate total on-road emissions (including starts, extended idling, etc.). These conversion factors were developed specifically for the El Paso area based on calculated ratios between total emissions and running emissions from past regional emissions analyses[1]. Link-level results are then aggregated at the TAZ, district, and network levels. Emission estimations can be done for selected time periods and daily (if applicable).

NON-TDM MODULE

This module was developed to estimate emissions benefits of individual projects/strategies that are usually not modeled by the TDM. This includes strategies that target vehicle idling or vehicle replacement strategies. This module of the analysis tool allows for simplified calculations based on an emissions rate by vehicle type for selected analysis years, combined with user-input data on expected benefits.

[1] Note: These conversion factors were developed based on results of past regional emissions analyses/inventories conducted by TTI in the El Paso region. They provide a means of estimating the additional emissions such as starts and idling to assess overall order of magnitude. As mentioned previously, the emissions estimates are therefore meant for sketch planning only and not suitable for use for regulatory purposes.

Researchers identified a set of strategies for this module based on input from the El Paso MPO, and computation methods were developed for each (as shown in Table 1). The computational methods are consistent with existing methods such as those outlined in the MOSERS guide (*8*), with simplifying assumptions and adjustments to data inputs made to accommodate the overall framework of the sketch planning tool. These results and methods can provide a starting point for CMAQ analyses or other documentation. EFLTs were also developed for this module, consisting of emissions factors for specific vehicle types necessary for the computations. In this module, the running emissions factors were aggregated to speed-based daily rates representative of the vehicle category as a whole[2]. For example, running emission factors for transit buses were developed considering both gasoline and diesel fuel types. In the first step, the vehicle miles traveled (VMT) mix for gasoline and diesel transit vehicles was normalized to equate to 1.00. It was then applied to estimate hourly emissions factors by vehicle type. In the next step, an hourly mix was applied to the aggregate hourly emissions factors to obtain daily factors for the EFLTs. A similar process was followed for the other vehicle types that feature in Table 1, namely school buses, heavy duty trucks, and light-duty vehicles. In the case of idling emissions project level, MOVES runs were performed to estimate idling factors for all vehicle types. The VMT mix was normalized for the running emissions, and the emission factors were then multiplied with the normalized VMT mix to estimate average hourly idling factors.

[2] The VMT distribution by road type from the El Paso travel model shows that the vehicle activity is split predominantly between urban freeways and arterials. The composite running emissions factors in the EFLTs were therefore developed by weighting VMT percentages from these two roadway types with the corresponding roadway type emission factors.

Table 1. Strategies for Non-TDM Module

Strategy	Description and Approach to Computation
Heavy-Duty Truck Replacement	
	This calculation is based on user input data on the number of vehicles in the target fleet, average daily VMT per vehicle, average operating speed, and desired analysis year. Users are also required to enter the percentage reduction in emissions expected for each pollutant based on the emissions characteristics. This computation is intended for assessing the replacement of vehicles with newer model year vehicles or alternative fueled vehicles. It can also be used for assessing retrofits or engine repowering by entering the applicable emissions reductions expected for various pollutants.
Heavy-Duty Truck Idling Reduction	
	This calculation is based on user input data on the number of vehicles in the target fleet, average idling time prior to implementing the restriction, average idling time allowed per the new policy, compliance factor, and desired analysis year.
Light Duty Vehicle Replacement	
	This calculation is based on user input data on the number of vehicles in the target fleet, average daily VMT per vehicle, average operating speed, and desired analysis year. Depending on the new vehicle type (for example, new conventional gasoline vehicle, hybrid or electric vehicle, or alternative fuel vehicle), users are required to enter the percentage reduction in emissions expected for each pollutant.
School Bus Replacement	
	This calculation is based on user input data on the number of vehicles in the target fleet, average daily VMT per vehicle, average operating speed, and desired analysis year. Users are also required to enter the percentage reduction in emissions expected for each pollutant based on the emissions characteristics. This computation is intended for assessing the replacement of vehicles with newer model year vehicles or alternative fueled vehicles. It can also be used for assessing retrofits or engine repowering by entering the applicable emissions reductions expected for various pollutants.
Transit Bus Replacement	
	This calculation is based on user input data on the number of vehicles in the target fleet, average daily VMT per vehicle, average operating speed, and desired analysis year. Users are also required to enter the percentage reduction in emissions expected for each pollutant based on the emissions characteristics. This computation is intended for assessing the replacement of vehicles with newer model year vehicles or alternative fueled vehicles. It can also be used for assessing retrofits or engine repowering by entering the applicable emissions reductions expected for various pollutants.
School Zone Idle Reduction	
	This calculation assumes a reduction in idling for both school buses and light-duty passenger vehicles in a school pickup zone. The emissions reduction is estimated based on number of vehicles in each category, time spent idling prior to implementing the restriction, time vehicles are allowed to idle after the restriction, and compliance factor.
Bicycle and Pedestrian Facilities	
	This calculation is based on user input data on a new bicycle or pedestrian facility. Input data items include households in the area served by the facility, average vehicle trips per household, average trip length, and operating speed. Users are also to input information on percentage mode shift from auto trips to the bicycle or pedestrian facility.

3. SKETCH PLANNING TOOL USER GUIDE

This chapter provides user instructions and a description of data requirements for the tool. This user guidance is also provided in the form of an MS-PowerPoint® presentation, accompanying the sketch planning tool. This presentation will serve as a stand-alone guidance document for users of the tool and will be updated to reflect future changes made to the tool.

TOOL OVERVIEW

The sketch planning tool is in the form of an MS-Excel® based workbook. It is recommended that users create a copy of the workbook and rename the file to prevent saving changes on the original (blank) tool. Users should also enable macros to allow for full functionality of the tool.

On opening the file, the main interface of the tool will be displayed, as shown in Figure 3. Depending on the type of analysis being conducted, the user can then select the appropriate module (TDM or non-TDM) by clicking on the hyperlinks.

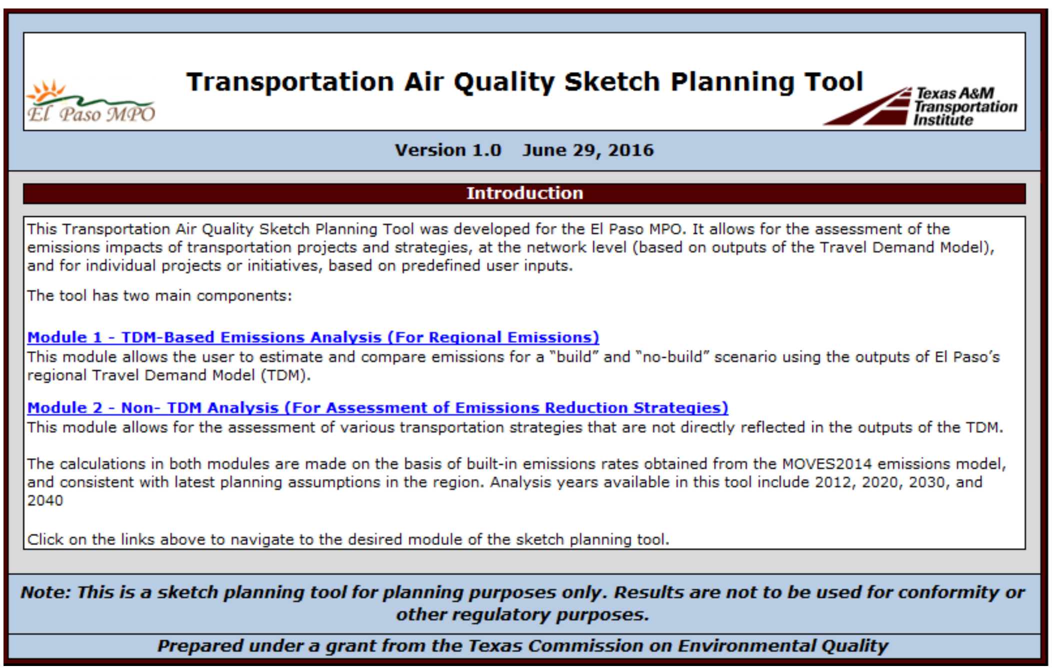

Figure 3. Main Page of Sketch Planning Tool

TDM- BASED MODULE

On selecting the TDM-based module, an interface as shown in Figure 4 will be displayed.

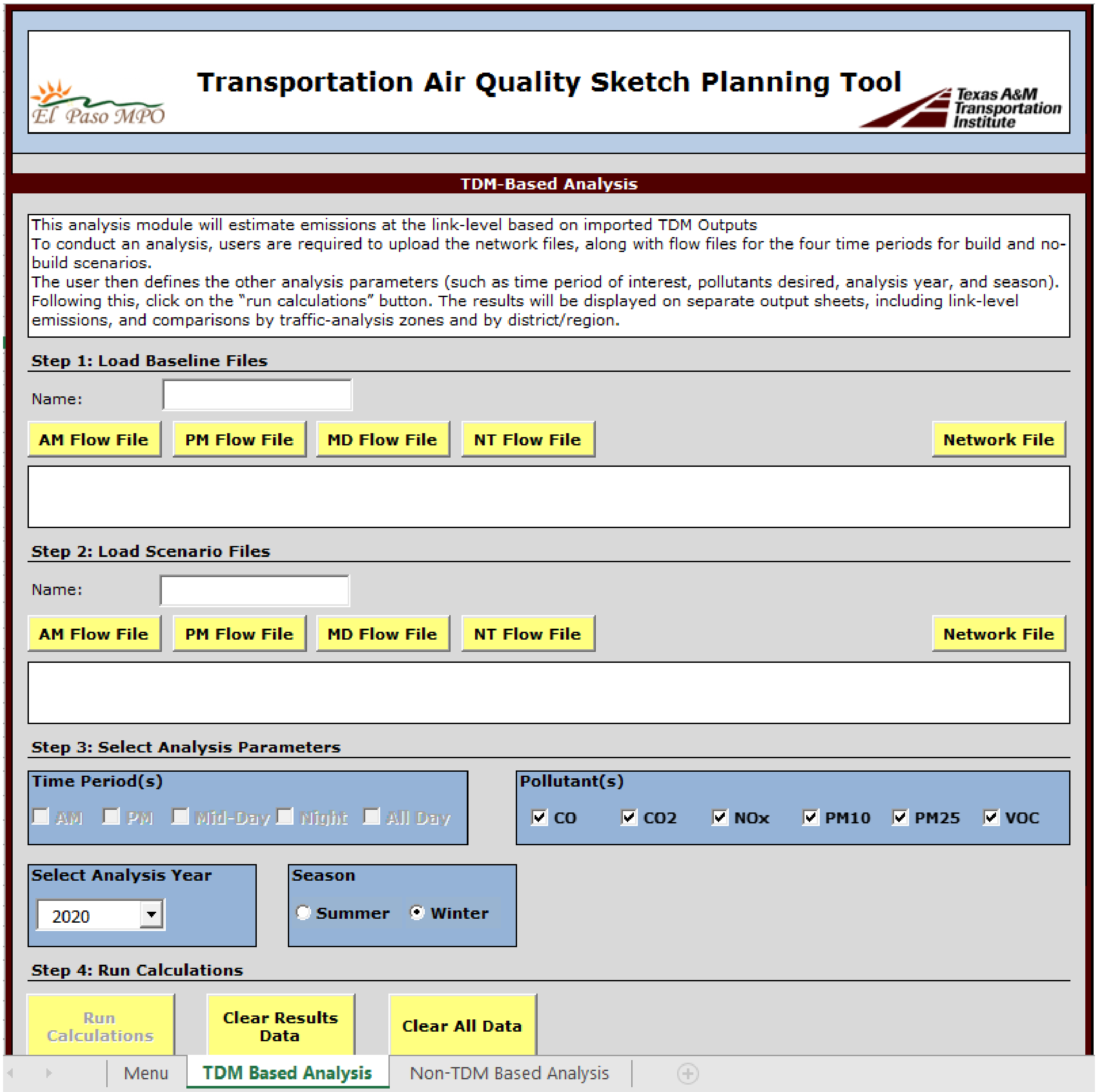

Figure 4. TDM-Based Analysis Interface

This analysis is set up for the comparison of two scenarios. These scenarios are termed as the "Baseline" and "Scenario" as a default and can be renamed by the user as desired (for example, as "Build" and "No Build" or "Option 1" and "Option 2", etc.). The user is required to upload TDM network files corresponding to both scenarios, along with flow files for four time periods (AM peak, PM peak, Midday [MD] and overnight [NT]).

The user then also defines other analysis parameters, including the desired analysis years (2012, 2020, 2030, and 2040), pollutants, time period, and season (winter/summer).

Detailed steps for running the analysis are described below:

- Step 1 – If not done so already, create a copy of the spreadsheet, rename the file, and enable macros to ensure tool functionality.
- Step 2 - Assemble required files for two analysis scenarios and save in a single folder location, as shown in Figure 5. Files required for each scenario are as follows:
    - Network flow files (in CSV format) and accompanying header files (in DCC format) for desired time periods: AM peak, PM peak, midday, and overnight.
    - 24-hr Network file and accompanying header file.
    - Additional points to note:
        - For all day calculations all four time period files are required, otherwise files corresponding to desired time periods are sufficient. Twenty-four hour flow files are not required and cannot be used for all day calculations.
        - File names must include an underscore followed by the time period marker (_AM, _PM, _MD, or _NT).
        - All header files must have the exact file name (except the extension) as the network and flow files that they correspond to.
        - The network and flow files must be in CSV format for upload.

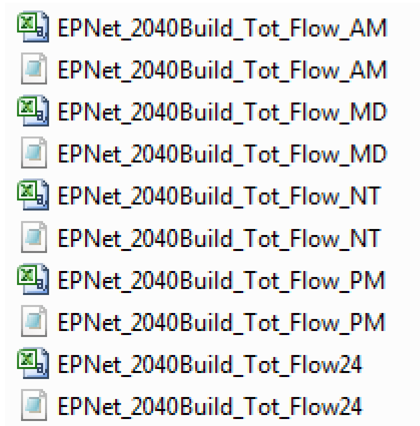

Figure 5. Example of Files and Naming Convention Required for TDM Analysis

- Step 3 – Name the scenarios and upload the files. The tool will automatically check files for the required data and ensures the guidelines in Step 2 are followed. As shown in Figure 6, successful upload of files will be indicated with a green color coding and a corresponding message, while errors in the file upload will be indicated in red.

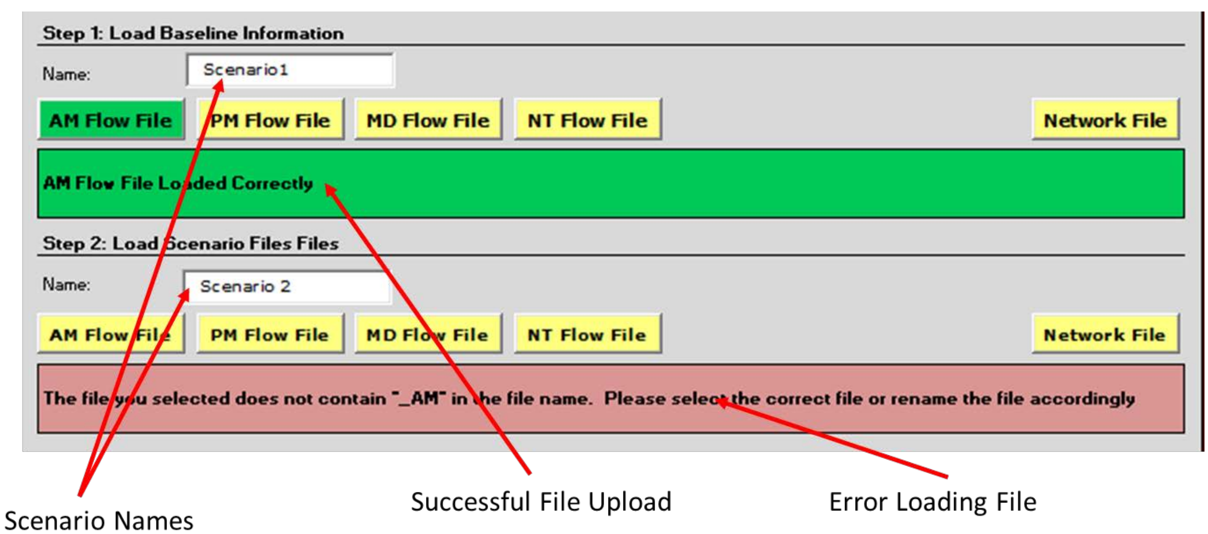

Figure 6. Error-Checking for File Uploads

- Step 4 – Select analysis parameters including the analysis years, pollutant(s), time period(s), and season of interest, as shown in Figure 7. Only time periods whose flow files have been uploaded will be enabled in the analysis parameter selections. The user should double-check to ensure that the analysis year selected in the tool for generating the emissions corresponds to the analysis year for the TDM data used, as the tool does not perform automated verification of this.

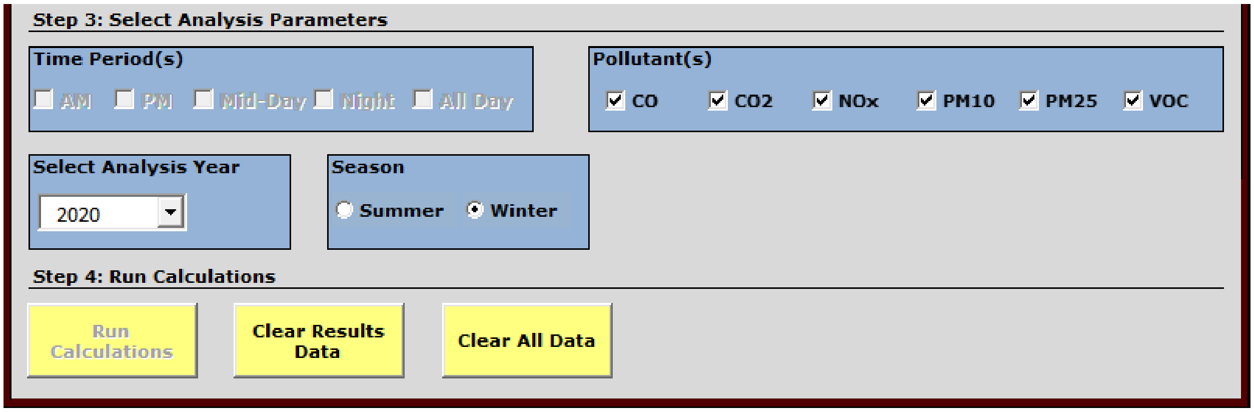

Figure 7. Analysis Parameters

- Step 5- Click "Run Calculations," also shown in Figure 7. The calculations may take up to 10–20 minutes, depending on computer speed and analysis parameters selected.

Outputs

Once the tool has completed the calculations, a set of outputs will be generated (emissions in lb/day). The user will be directed to a dynamic output graph showing summary results, along with menu of output worksheets, as shown in Figure 8. The output worksheets include:

- Graphs of the total emissions results for each time period.
- Interactive map (image-based, not linked to GIS) of district wide results for each time period, pollutant, and scenario, as shown in Figure 9.
- Summary results for each time period (by district and TAZ).
- Navigable results sheets, including link level results.

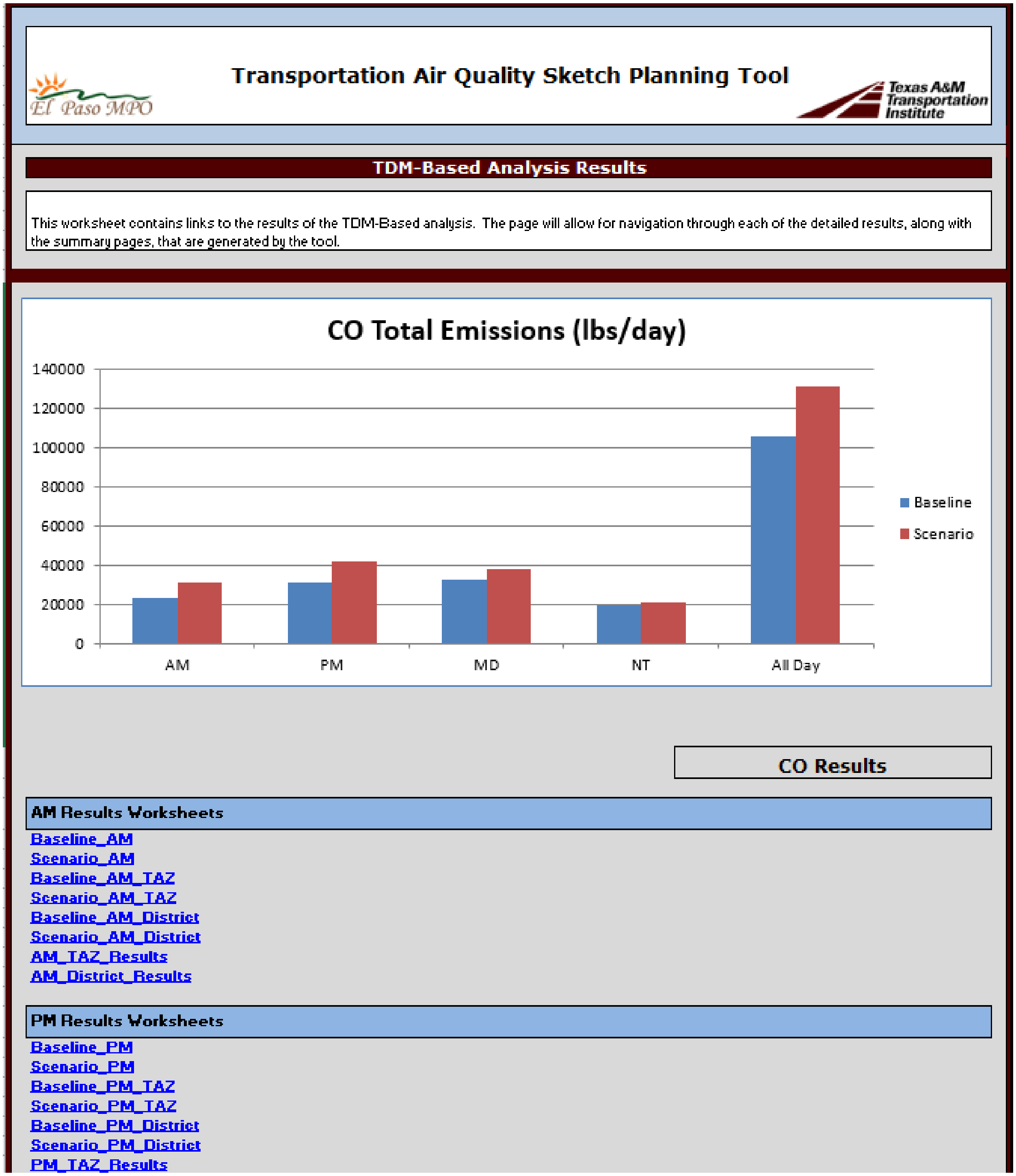

Figure 8. Graphical Output and Output Navigation Page

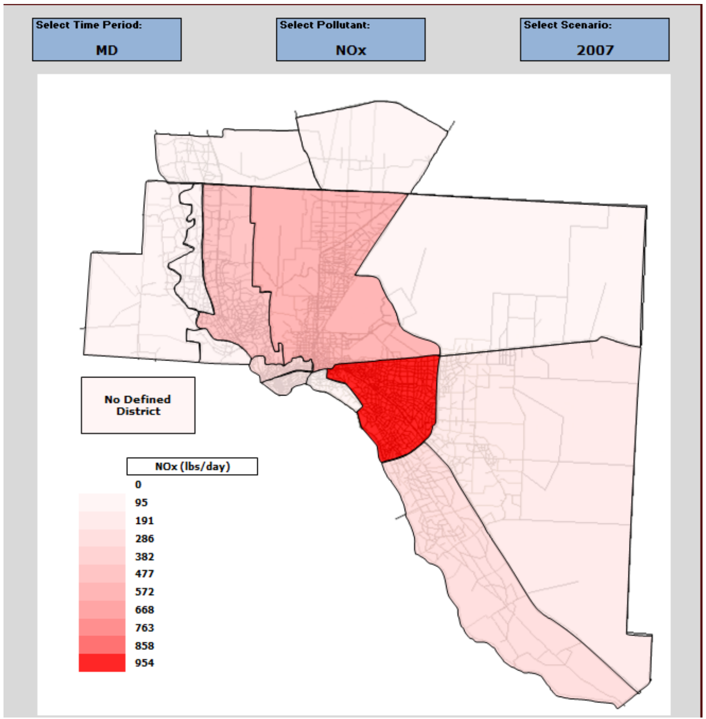

Figure 9. Example Map Output

The tabular summaries of outputs, which are linked to specific TAZs and districts can be exported into separate spreadsheets for further analysis, or linked to GIS data for spatial analysis or advanced mapping functions.

Running Additional Analysis Scenarios

Re-running a scenario with new files or for modified analysis parameters (pollutants, time period) without clearing the results generated in the spreadsheet can create enormous machine slow down and take multiple hours to complete a run. Functions to clear the data are provided, as shown in Figure 10.

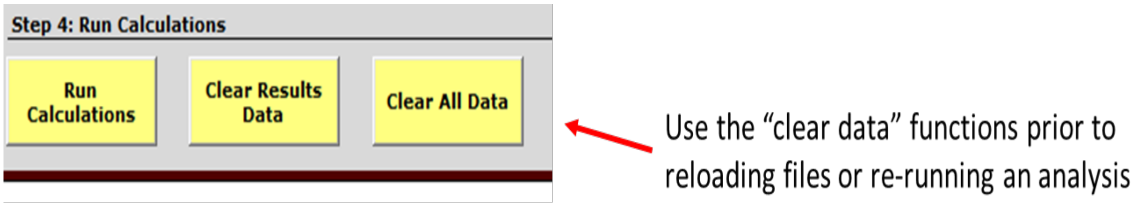

Figure 10. Clear Data Functions

The "clear results data" function can be used to clear results only; this keeps the input files intact and allows for scenarios to be run with different analysis parameters. The "clear all data" function, on the other hand, can be used to clear all data including input files. Alternatively, a new copy of the blank tool can be saved and used to conduct a new analysis.

NON-TDM MODULE

On selecting this module, an interface as shown in Figure 11 will be displayed.

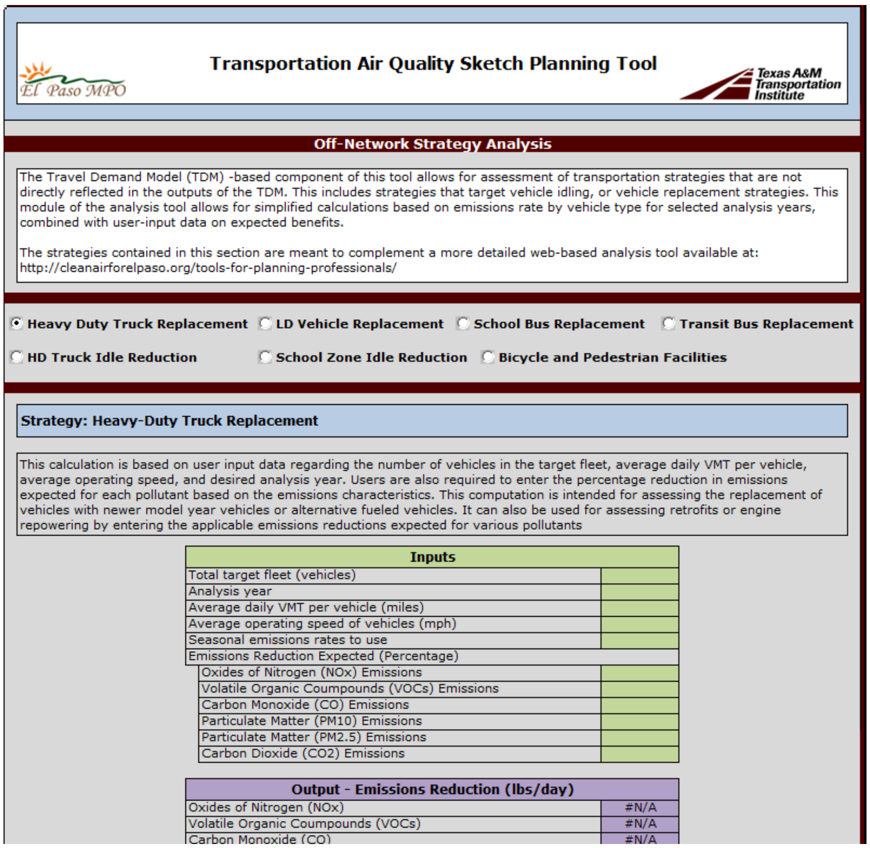

Figure 11. Non-TDM Module

The user is then required to select the strategy of interest by clicking on the corresponding radio button. The strategies include:

- Heavy-Duty Truck Replacement.
- Heavy-Duty Truck Idling Reduction.
- Light Duty Vehicle Replacement.
- School Bus Replacement.

- Transit Bus Replacement.
- School Zone Idle Reduction.
- Bicycle and Pedestrian Facilities.

Depending on the strategy selected, input and output fields will be displayed corresponding to the particular strategy. The user then needs to enter required input parameters, including:

- Strategy-specific inputs.
- Analysis year (2012, 2020, 2030, 2040).
- Season (winter/summer)

Based on the inputs, outputs are automatically generated for all pollutants in the corresponding output fields and are displayed as lb/day change in emissions.

Additional Guidance for Strategy-Specific Inputs

The strategies in the non-TDM module require strategy-specific user inputs for evaluation. While several of these inputs are selected by the user based on local data and knowledge on a proposed strategy, this section lists additional resources that may be consulted for guidance on reasonable assumptions for input data. The MOSERS guidebook also provides additional information on the estimation of reductions for a larger range of strategies, including alternative equations and calculation methodologies for some of the strategies listed here (*8*).

The seven strategies contained in the tool can be broadly classified as:

- Vehicle Replacement-Based Strategies.
    - Heavy-Duty Truck Replacement.
    - Light Duty Vehicle Replacement.
    - School Bus Replacement.
    - Transit Bus Replacement.
- Idle-Reduction Strategies.

  - o Heavy-Duty Truck Idling Reduction.
  - o School Zone Idle Reduction.
- VMT Reduction Strategies.
  - o Bicycle and Pedestrian Facilities.

In the case of vehicle replacement-based strategies, key inputs include identifying the number of vehicles affected, their average operating speeds, and estimated percentage reductions for various pollutants expected due to the vehicle replacement. This strategy can also be applied to vehicle retrofits or fuel conversions. The percentage reductions in emissions of various pollutants can be estimated based on knowledge of the type of vehicle in the existing fleet that is being replaced and the replacement vehicle. For example, the percentage reduction in NO_x emissions expected for the replacement of an older heavy-duty diesel truck with a newer model can be based on the difference between emissions standards that the two trucks were required to meet.

The North Central Texas Council of Governments has compiled information about current and historical emissions standards that may be useful for this purpose (9). Additional sources include the EPA's Emissions Standards Reference Guide (10) and the Department of Energy's Alternative Fuels Data Center (11), for information on emissions benefits of alternative fueled vehicles. Similarly, in the case of vehicle retrofits, the estimated reductions in emissions can be based on information such as the EPA's Clean Diesel Verified Technology List (12) and the SmartWay Program Designated List (13). Certain types of retrofits or alternative fueled vehicles may only reduce emissions of certain pollutants; for example, selective catalytic reduction devices will reduce NO_x, whereas diesel particulate filters are geared toward reducing PM.

Idle reduction based strategies require key inputs such as the target fleet numbers, the proposed idling restriction timing, and the average idling time of vehicles prior to implementation of the restriction, along with an estimated compliance factor. The Department of Energy's National Idling Reduction Network News (14) is a resource that can be consulted for information on current idling restrictions and programs nationwide. TTI has also performed past research on the prevalence of vehicle idling at various types of generators in Texas (15).

In terms of VMT reduction strategies, this tool includes an estimation methodology of bicycle and pedestrian facilities that is based on the number of households in the area served by the facility, average vehicle trips per household, average trip length, and operating speed. Users are also to input information on percentage mode shift from auto trips to the bicycle or pedestrian facility. In the absence of local studies or estimates of modal shift/new users of the bicycle or pedestrian facility, NCHRP Report 552 (16) provides a sketch-level methodology for assessing use of bicycle and pedestrian facilities that could be consulted for reference.

4. SUMMARY AND CONCLUSIONS

This project produced a functional, spreadsheet-based tool that can be applied by the El Paso MPO for evaluating emissions impacts of transportation strategies for planning purposes. The TDM-based module can be used for the evaluation of strategies or projects that are modeled as part of the regional TDM. In this case, TDM files can be loaded into the tool, which automatically extracts pertinent information for emissions estimation. The tool then uses built-in emissions factors (developed using the MOVES model, for the El Paso region) for estimating emissions at the link, TAZ, district, and network levels. This information will allow for an evaluation of directional changes or potential indication of emissions impacts for alternative scenarios modeled in the TDM. The non-TDM module provides automated calculations of the potential emissions reductions for a set of strategies. Calculations are consistent with the MOSERS guidebook and other established processes/literature, and include built-in emissions factors developed for the relevant vehicle types for each strategy.

Further enhancements or ideas for future expansion of this work include:

- Performing periodic updates to emissions factors and analysis years to corresponding to updated model years and conformity years for the regional TDM.
- Automation/integration with GIS for further spatial analysis and mapping of results. Currently, the tool outputs need to be manually exported and appended to GIS files for such purposes.
- Expansion of the non-TDM module to include other strategies as desired by the MPO.
- Expansion and modification of the tool to include the capability of conducting mobile source air toxics analysis.
- Implementation of the tool in a web-based format, potentially integrating it with the previously developed public outreach website and calculator (available at http://cleanairforelpaso.org/).

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APPENDIX A– QUALITY ASSURANCE PROJECT PLAN

FY 14-15
PGA FY 14-1
Task 3

Quality Assurance Project Plan

Transportation and Air Quality Sketch Planning Tool for the El Paso Region

December 2014, Revision 1.0

Prepared by:
Principal Investigator: Joe Zietsman, P.E., Ph.D.
Texas A&M Transportation Institute

QAPP Category Number: III
Type of Project: Data Evaluation

PREPARED UNDER A GRANT FROM THE
TEXAS COMMISSION ON ENVIRONMENTAL QUALITY

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The content, findings, opinions, and conclusions are the work of the author(s) and do not necessarily represent findings, opinions, and/or conclusions of the TCEQ.

QAPP Distribution and Approvals

Title of Project: Transportation and Air Quality Sketch Planning Tool for the El Paso Region

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- Tara Ramani, P.E., Air Quality Program, Texas A&M Transportation Institute
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Approvals

Joe Zietsman, Ph.D., P.E., TTI Principal Investigator

2/12/15
Date

2

DRAFT

Table of Contents

DRAFT

1. PROJECT DESCRIPTION AND OBJECTIVES

The Texas A&M Transportation Institute (TTI) has prepared this Level III Quality Assurance Project Plan (QAPP) for the El Paso MPO and the Texas Commission on Environment Quality (TCEQ), consistent with EPA National Risk Management Research Laboratory (NRMRL) for secondary data projects [1, 2]. TTI is serving as a contractor to the El Paso MPO for the technical execution of this project.

1.1 Background

The Rider 8 program was established in 1995 when the Texas Legislature appropriated funds to support local air quality planning efforts in areas around the state. In anticipation of tougher federal Ozone nonattainment standards, the El Paso region was among those made eligible to receive funding under this program. This project is one of the activities ("Task 3: Transportation and Air Quality Sketch-Planning Tool") being conducted by the El Paso MPO as part of their Rider 8 Work Plan, and TTI is serving as a contractor for the execution of the project.

1.2 Project Objectives

The overall goal of this project is to develop a sketch-planning tool that can be used to link travel demand model outputs with emissions rates to allow users to examine potential impacts of transportation priorities at the corridor and sub-network level. The tool will be developed in spreadsheet calculator format and will perform calculations on the basis of user inputs entered into the spreadsheet.

DRAFT

2. ORGANIZATION AND RESPONSIBILITES

2.1 Project Personnel

All project activities will be conducted by TTI in cooperation with and oversight from the El Paso MPO and the TCEQ. Project personnel, including Quality Assurance (QA) and related responsibilities for each are described below.

- Dr. Joe Zietsman of TTI will serve as the Principal Investigator and QA Officer for this project. He will be responsible for oversight on all project tasks, to ensure timely and satisfactory completion of the work and project deliverables.
- Ms. Tara Ramani of TTI will serve as a key investigator on this project responsible for project planning and execution.
- Dr. Reza Farzaneh of TTI will serve as a key investigator responsible for technical activities, as well as QA Manager overseeing data analysis and data compilation activities on the project.
- Other TTI staff working on this project will include Mr. Jeremy Johnson and Dr. Yuche Chen. Dr. Chen will work on developing the quantification methods as well as identifying data sources that will be used in the spreadsheet tool. Mr. Johnson will be involved with the development of the spreadsheet tool.
- Christine Ponce-Diaz of the El Paso MPO will serve as the Rider 8 Grant Planner primarily responsible for coordinating with TTI and TCEQ on the project.
- Leigh Ann Brunson of the TCEQ will serve as the Rider 8 Grant Manager overseeing the program in El Paso including but not limited to the deliverables produced for each work plan task.
- Jocelyn Mellberg of the TCEQ will serve as the Rider 8 Coordinator working with the El Paso MPO on inquiries related to the grant and the execution of work plan tasks and deliverable items.
- Amanda Sharp of the TCEQ will serve as Air Quality Planning Staff for the El Paso Rider 8 Area.
- Margaret Earnest of the TCEQ will serve as Back-up Air Quality Planning Staff for the El Paso Rider 8 Area.
- Fernando Mercado of the TCEQ will serve as Technical Staff for the El Paso Rider 8 Area.

2.2 Project Schedule and Key Milestones

Key project milestones are listed in the table below.

Milestone/Deliverable	Due Date
QAPP Acceptable to TCEQ and EPA	On initiation of project
Literature Review and Identification of Potential Strategies (Task 1)	End of 5th month after the Project Initiation
Selection of Strategies for Inclusion (Task 2)	End of 7th month after Project Initiation
Quantification Methods/Data Sources (Task 3)	End of 9th month after Project Initiation
Develop Spreadsheet Tool (Task 4)	End of 11th month after Project Initiation
Compile Data and Conduct Pilot Application (Task 5)	End of 13th month after Project Initiation
Demonstration/Training Session for MPO Staff (Task 6)	End of 15th month after Project Initiation
Final Deliverables Due (Task 7)	End of 16th month after Project Initiation

3. SCIENTIFIC APPROACH

This study involves the development of a sketch planning tool that implements calculations and uses some built-in data (along with user-input data) for determining the emissions benefits of different transportation strategies and scenarios. The data built into the spreadsheet tool will all be obtained from established sources of secondary data from state and federal agencies or other published studies.

3.1 Data Needed

While the data needed for this project are not entirely defined, as they will depend on the findings of the initial project tasks, they are anticipated to include:

- Outputs from the El Paso MPO's regional travel demand model for a base year model run, including network links, traffic flows and average speeds.
- Emissions rates by source use type for the El Paso region
- Additional data such as default values for parameters used in estimation methodologies

3.2 Sources of Secondary Data

Data sources are expected to include published data and information from published, peer-reviewed documents and public-sector (state, local and federal) sources, including research reports, guidebooks, emissions inventory documents, etc. The data for this project will be assembled from various sources, and no independent data collection efforts will be undertaken. Preliminary data sources may be assembled during Task 3 and data will be assembled as part of both Task 3 and Task 4, and the latest available/most current data at that time will be used in the spreadsheet tool. Emissions rates for use in the project will either be taken from TTI's work for the TCEQ on development of statewide mobile source emissions inventories or generated by TTI using methods consistent with this work[1].

4. QUALITY METRICS

In this section, the quality requirements for the data used in this study and the procedures for determining the quality of the data are described.

4.1 Quality Requirements

The two main types of data in this project are 1) secondary data from existing sources/studies, and 2) emissions rates extracted from mobile source emissions inventories or generated by TTI using methods consistent with this work. The secondary data from existing sources includes reports, guidebooks and other published work from established sources such as reports by the Transportation Research Board, the Federal Highway Administration, the United States Environmental Protection Agency, etc. For this type of data, accuracy, validity and representativeness of the data will be assessed and documented by the quality assure/quality control (QA/QC) manager on the basis of the source of the data (for example, datasets published by state and federal sources are expected to be of sufficient representativeness and quality), taking into account QA/QC procedures undertaken in the collection and assembly of this data. For emissions rates from mobile source emissions inventories, the QA/QC manager (who has extensive experience with the use of such data sets) will ensure that accurate data inputs and assumptions are used in the generation of rates, or that the rates are obtained from previous work approved by the TCEQ.

4.2 Procedures for Determining Quality of the Secondary Data and Model Outputs

Specific checks for determining the quality of data used will include:

- Where possible, corroborating data used with other sources of the same/similar data, and reporting any comparisons.
- Checking all data used from other sources for accompanying documentation describing primary data sources and qualifications of persons who prepared the data.

[1] Note: TTI is under contract with TCEQ to develop statewide on-road mobile source inventories from which emissions rates can be obtained. See *Development and Production of Statewide, Non-Link Based, On-Road Mobile Source MOVES Emissions Inventories*, Prepared by the Texas A&M Transportation Institute, Prepared for the Texas Commission on Environmental Quality, August 2013.

- Documenting and cross-checking mobile source emissions inventories outputs with other published sources of emissions rates/data.

TTI will thoroughly QA/QC all work performed, including calculations, validation of model inputs, checks for data entry errors, etc. This effort will cover and surpass the project requirement of a 10 percent audit of data quality, and will be documented in the final report.

4.3 Documents and Records Retention

Documents and data related to the project will be kept at TTI's offices for a minimum of 3 years on TTI servers. Copies of report and relevant data will also be supplied to the El Paso MPO and the TCEQ for their records. If TTI decides to terminate the records after the expiration of this period, the El Paso MPO and the TCEQ will be informed of this decision and there will be an opportunity for transferring all public records to the sponsor. Sufficient documentation will be retained to ensure that any analyses/computations conducted during the project can be replicated with the available information.

4.4 Disclaimer

While the quality of secondary data will be evaluated as outlined in Section 4.2, there may be instances where the quality of the secondary data could not be determined (for example, results from interviews). In such cases, a disclaimer will be included stating that the quality of that specific data element cannot be determined.

5. DATA ANALYSIS, INTERPRETATION, AND MANAGEMENT

5.1 Data Reporting Requirements

The data analysis procedures, including data reduction procedures are not entirely defined, but will include methods to estimate emissions impacts of selected transportation strategies. All data sources and assumptions that form part of these analyses, as well as equations and calculations used will be reported as part of the final report.

5.2 Data Validation

The primary data validation methodology for this project is to ensure that the data used is in accordance with the quality metrics listed in Section 4 (which covers data validity), combined with the use of appropriate data analysis procedures. All data reported in this project will be compared wherever possible to other data sources (such as existing emissions inventories or past studies) and known datasets to ensure that the data are of similar order of magnitude and within expected ranges. All such comparisons will be reported.

5.3 Data Analysis and Summary Procedures

Given the nature of the overall project, the data analyses results will cover a range of scenarios/cases that will be reported. Analysis of the results will only be qualitative discussions and inferences, with no descriptive or inferential statistics being reported.

5.4 Data Storage Requirements

All data used in the project will be compiled into an MS-Excel spreadsheet tool, with appropriate explanatory notations listing units, data sources and other pertinent information.

6. REPORTING

6.1 Deliverables

Interim project deliverables/milestones are as listed in Section 2.2. TTI will be responsible for the timely submittal of all deliverables. Project data (in MS-Excel format) will be made available to the El Paso MPO and TCEQ on request.

6.2 Final Products

TTI will submit the draft final report (MS-Word format) to the El Paso MPO and the TCEQ for review three weeks prior to the project end and the finalized report will be submitted by June 30, 2016. The report will include:

- An executive summary and abstract.
- An introduction that discusses background and objectives, including relationships to other studies.
- A summary of data analysis results, analysis procedures, equations and calculations used.
- A discussion of the pertinent accomplishments, findings, and limitations of the work completed.
- A discussion of lessons learned, recommendations and scope for future work.

In addition to the final report the spreadsheet based analysis tool will also be submitted as a final deliverable no later than June 30, 2016.

7. REFERENCES

1. United States Environmental Protection Agency Requirements for Quality Assurance Project Plans http://www.epa.gov/quality/qs-docs/r5-final.pdfAccessed October 2014
2. EPA National Risk Management Research Laboratory (NRMRL) QAPP Requirements for Secondary Data Projects http://www.epa.gov/quality/qs-docs/found-data-qapp-rqts.pdf Accessed October 2014

APPENDIX B– DEVELOPMENT OF EMISSIONS FACTORS

For use in the tool, emissions factors were aggregated into four time periods. The emissions factors were aggregated from a set of recently developed emission factors covering all source types and pollutants. Figure B- 1 provides the process of converting emission factors into daily and four time periods required for emissions calculation, and also shows all the inputs required for estimating aggregated look-up tables that are built into the sketch planning tool. Table B- 1 lists key modeling information used in obtaining the emissions factors. Latest modeling inputs such as fuel formulation, meteorological data, vehicle age distribution, etc. were utilized in developing the emission factors, as shown in Table B- 2 through Table B-6.

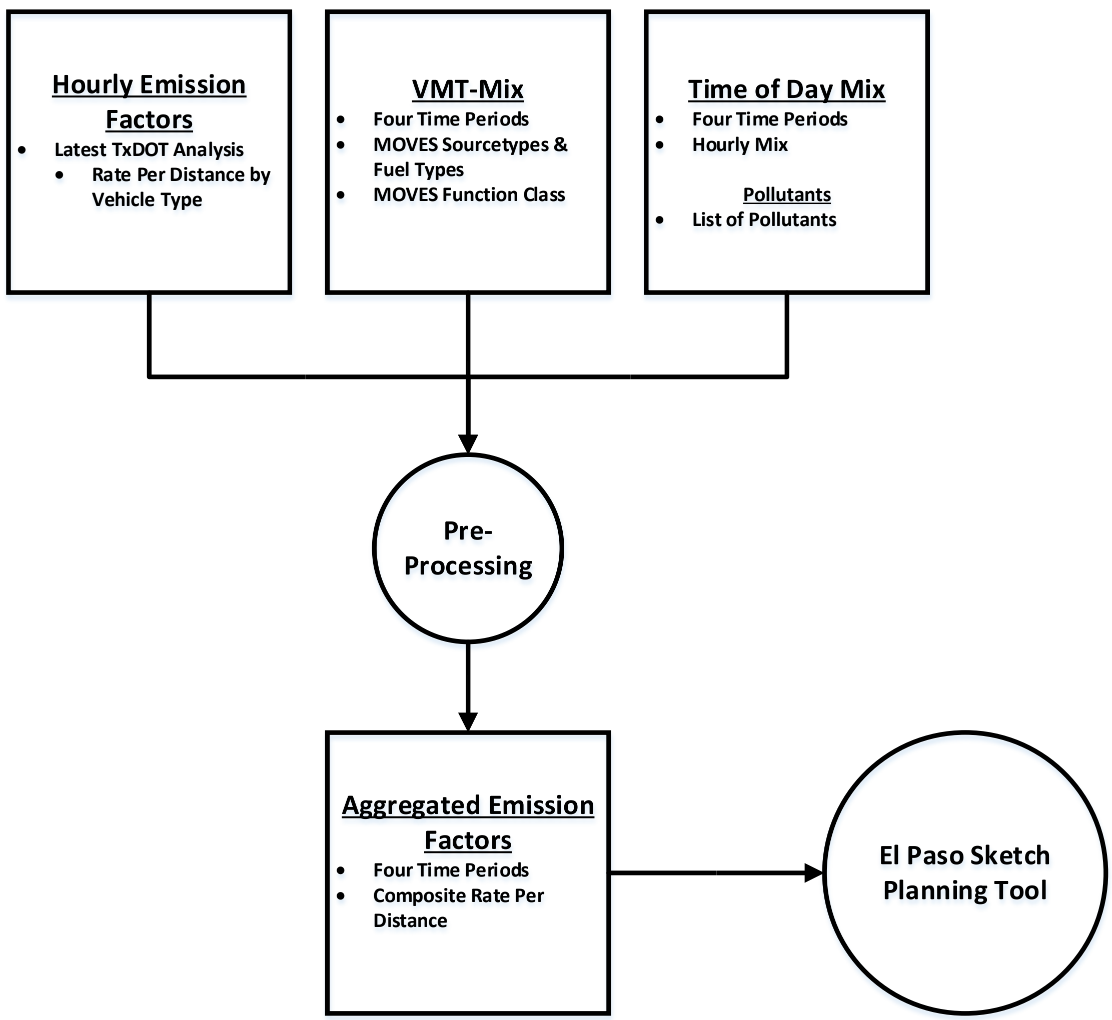

Figure B-1. Aggregation of Emissions Factors

Table B-1. Modeling Information

Description	Input Parameter Values	Comment
MOVES Model Version	MOVES2014a	
MOVES Model County	El Paso	
Time Periods	Hourly	
Functional Class	Urban Restricted, Rural Restricted, Urban Unrestricted and Rural Unrestricted	
Speed	1-75 mph at 5 mph increments	
Pollutant	Carbon Monoxide (CO) Particulate Matter – 10 Micrometer or less (PM_{10}) Particulate Matter – 2.5 Micrometer or less ($PM_{2.5}$) Nitrogen Oxides (NO_x) Volatile Organic Compounds (VOC) Carbon Dioxide (CO_2)	
VMT Mix	EPA's 23-vehicle class	Applied during post-processing of emission factors
Hourly Mix	24-hour and four-time period (AM-Peak, PM-Peak, Off-Peak, and Overnight) mix	Applied during post-processing of emission factors
Calendar Year	2012, 2020, 2030, and 2040	Will also include the first (base) year of the mobility plan, as required
Evaluation Month	1 (Dec-Feb) 7 (June-Aug)	

Table B-2. MOVES Inputs and Sources

Input Parameter Name	Description	Source
Source Type Population	Input the number of vehicles in the geographic area that is to be modeled for each vehicle.	TXDMV registration data
Source Type Age Distribution	Input that provides the distribution of vehicle counts by age for each calendar year and vehicle type. TXDMV registration data are used to estimate the age distribution of vehicle types up to 30 years. The distribution of age fractions should sum up to 1.0 for all vehicle types for each analysis year.	TXDMV registration data & MOVES default
Average Speed Distribution	Input average speed data specific to vehicle type, road type, and time of day/type of day into 16 speed bins. The sum of speed distribution to all speed bins for each road type, vehicle type, and time/day type would be 1.0.	MOVES Default
Road Type Distribution (VMT Fractions)	VMT by road type. VMT fraction is distributed between the road type and must sum to 1.0 for each source type.	MOVES Default
Fuel Supply	Existing fuels (gas and diesel) and associated market share for each fuel.	TTI (*See Table B- 3)*
Fuel Formulation	Fuel properties in the MOVES database.	TTI (*See Table B- 3*)
Meteorology	Regional Specific data on temperature and humidity.	TTI (*See Table B-4)*
I/M Coverage	Input I/M coverage record for each combination of pollutants, process, county, fuel type, regulatory class and model year are specified using this input.	*See Table B- 5*
Alternative Vehicle Fuel Technology	Input fuel engine fractions (i.e., Gasoline vs. Diesel Engines types in the vehicle population) for all vehicle types.	TXDMV registration data & MOVES default

Table B-3. Fuel Supply and Fuel Formulation

Fuel Region ID	Fuel Year ID	Month Group ID	Fuel Formulation ID	Market Share	Market Share CV
370010000	2014	1	13101	1	NULL
370010000	2014	1	30001	1	NULL
370010000	2014	7	10703	1	NULL
370010000	2014	7	30001	1	NULL
370010000	2012	1	8843	1	NULL
370010000	2012	1	31002	1	NULL
370010000	2012	7	8848	1	NULL
370010000	2012	7	31002	1	NULL

Fuel Year	2012			2014		
Fuel Type	**Winter Gasohol (E10)**	**Summer Gasohol (E10)**	**Diesel**	**Summer Gasohol (E10)**	**Winter Gasohol (E10)**	**Diesel**
fuelFormulationID	8843	8848	31002	10703	13101	30001
fuelSubtypeID	12	12	20	12	12	20
RVP	11.61	7	0	6.83	11.61	0
sulfurLevel[a]	30	30	5.43	14.84	30	3.56
ETOHVolume	10	10	0	9.77	10	0
MTBEVolume	0	0	0	0	0	0
ETBEVolume	0	0	0	0	0	0
TAMEVolume	0	0	0	0	0	0
aromaticContent	22.05	25.67	0	25.79	22.05	0
olefinContent	7.05	9.42	0	8.39	7.05	0
benzeneContent	0.63	0.63	0	0.4	0.63	0
e200	53.74	45.16	0	47.21	53.74	0
e300	87.4	83.72	0	87.77	87.4	0
volToWtPercentOxy	0.3653	0.3653	0	0.3653	0.3653	0
BioDieselEsterVolume	NULL	NULL	0	NULL	NULL	NULL
CetaneIndex	NULL	NULL	NULL	NULL	NULL	NULL
PAHContent	NULL	NULL	NULL	NULL	NULL	NULL
T50	194.22	211.23	0	211.33	194.22	0
T90	310.28	324.92	0	306.75	310.28	0

[a] For modeling analysis year 2017 and later years, gasoline sulfur level value of 10 will be used.

Table B-4. Hourly Meteorological Data

Hours	Temperature (°F)		Relative Humidity (%)	
	Summer	Winter	Summer	Winter
12:00 a.m.	81.79	49.27	37.25	37.74
1:00 a.m.	81.05	47.90	38.45	40.16
2:00 a.m.	78.79	47.15	41.82	41.71
3:00 a.m.	77.71	46.66	44.20	42.80
4:00 a.m.	77.07	45.42	45.48	45.24
5:00 a.m.	75.45	44.76	48.25	46.03
6:00 a.m.	74.26	44.69	49.49	46.61
7:00 a.m.	74.18	43.97	50.23	48.80
8:00 a.m.	76.31	44.48	48.13	46.89
9:00 a.m.	79.20	46.24	44.01	44.21
10:00 a.m.	80.69	51.06	41.51	36.43
11:00 a.m.	85.32	54.70	34.30	32.54
12:00 p.m.	87.80	55.84	30.79	30.85
1:00 p.m.	89.00	59.56	28.89	26.26
2:00 p.m.	91.75	60.89	25.11	24.51
3:00 p.m.	92.79	61.52	23.67	23.94
4:00 p.m.	93.05	62.13	23.18	22.86
5:00 p.m.	92.99	60.64	23.10	24.14
6:00 p.m.	92.41	58.97	23.38	25.10
7:00 p.m.	91.92	55.61	23.68	29.12
8:00 p.m.	89.12	53.90	26.43	30.99
9:00 p.m.	86.76	53.17	29.57	32.04
10:00 p.m.	85.64	51.26	31.35	35.16
11:00 p.m.	83.13	49.82	34.91	36.73

Table B-5. El Paso Region I/M Data

I/M Program ID	140	121	151	160	Identifies program number with MOVES Database.
Pollutant Process ID	101, 102, 201, 202, 301, 302,	101, 102, 201, 202, 301, 302,	112	112	
Source Use Type	21, 31, 32	21, 31, 32	21, 31, 32	21, 31, 32	
Begin Model Year	1996	X	X	1996	
End Model Year	y	1995	1995	y	
Inspection Frequency	1	1	1	1	Annual testing; program specifications
Test Standards ID	51	12	41	45	Identifies program number with MOVES Database.
Test Standards Description	Exhaust OBD Check	Two-mode, 2500 RPM/Idle Test	Evaporative Gas Cap Check	Evaporative Gas Cap and OBD Check	
I/M Compliance	93.12% for source type 21, 91.26% for source type 31 and 86.6% for source type 32				Expected compliance (%) - MOVES Default
Begin Model Year and End Model year define the range of vehicle model years covered by I/M Program. Here Begin Model Year represented by "x" is calculated as YearID – 24 and End Model Year represented by "y" is calculated as YearID – 2.					

Table B-6. Diurnal Distribution of Vehicle Activity

Hours	24-Hour	AM Peak	Mid-day	PM Peak	Overnight
12:00 a.m.–12:59 a.m.	0.010707	0	0	0	0.049398
1:00 a.m.–1:59 a.m.	0.007026	0	0	0	0.032416
2:00 a.m.–2:59 a.m.	0.005971	0	0	0	0.027548
3:00 a.m.–3:59 a.m.	0.00542	0	0	0	0.025006
4:00 a.m.–4:59 a.m.	0.00767	0	0	0	0.035387
5:00 a.m.–5:59 a.m.	0.01885	0	0	0	0.086967
6:00 a.m.–6:59 a.m.	0.038834	0.230993	0	0	0
7:00 a.m.–7:59 a.m.	0.065309	0.388471	0	0	0
8:00 a.m.–8:59 a.m.	0.063975	0.380536	0	0	0
9:00 a.m.–9:59 a.m.	0.054502	0	0.133445	0	0
10:00 a.m.–10:59 a.m.	0.052003	0	0.127326	0	0
11:00 a.m.–11:59 a.m.	0.055351	0	0.135523	0	0
12:00 p.m.–12:59 p.m.	0.058348	0	0.142861	0	0
1:00 p.m.–1:59 p.m.	0.059471	0	0.145611	0	0
2:00 p.m.–2:59 p.m.	0.061601	0	0.150826	0	0
3:00 p.m.–3:59 p.m.	0.067148	0	0.164408	0	0
4:00 p.m.–4:59 p.m.	0.072022	0	0	0.34842	0
5:00 p.m.–5:59 p.m.	0.074261	0	0	0.359252	0
6:00 p.m.–6:59 p.m.	0.060427	0	0	0.292327	0
7:00 p.m.–7:59 p.m.	0.045971	0	0	0	0.212094
8:00 p.m.–8:59 p.m.	0.037325	0	0	0	0.172205
9:00 p.m.–9:59 p.m.	0.032779	0	0	0	0.151231
10:00 p.m.–10:59 p.m.	0.026339	0	0	0	0.121519
11:00 p.m.–11:59 p.m.	0.01869	0	0	0	0.086229

APPENDIX C– FURTHER DETAILS OF EMISSIONS ESTIMATION

Emissions estimates calculated will be consistent with the current methodology used for conformities but at more aggregate level. Figure C- 1 provides the process and information necessary for calculating emissions at link level and aggregation periods available for users to select.

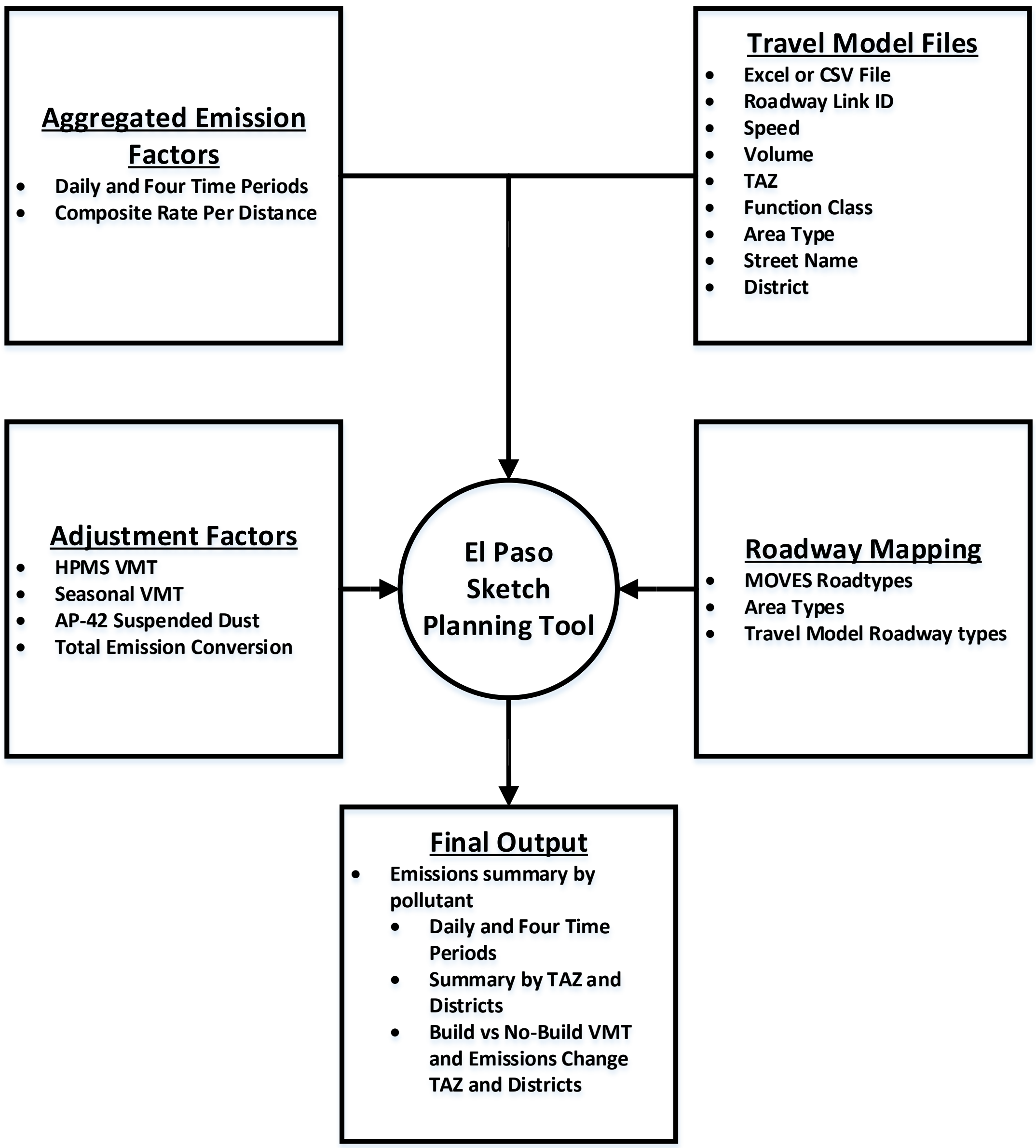

Figure C-1. Emissions Estimation Process

Emissions estimates are based on vehicle activity and emissions factors to create emissions estimates. To calculate emissions factors for average operational speeds falling between two of the MOVES speed bin speeds, emissions factors are interpolated using a factor developed from the inverse link speed and the inverse high and low bounding speed bin speeds. The module uses the MOVES method to interpolate emissions factors as shown in the following example. This example interpolates an emissions factor corresponding to an average speed of 41.2 mph. The emissions were calculated using the following formula:

$$\text{Emissions}_{Link} = \text{VMT}_{Link} \times \text{EF}_{Aggregated} \text{ x Conversion Factors}_{\text{HPMS, Seasonal, Total Emissions}}$$

Note – in the case of PM2.5 and PM10, the AP-42 suspended dust factors are also applied by roadway type to estimate suspended dust emissions.

The interpolated emissions factor (EF_{Interp}) is expressed as:

$$EF_{Interp} = EF_{LowSpeed} - FAC_{Interp} \times (EF_{LowSpeed} - EF_{HighSpeed})$$

Where:

$EF_{LowSpeed}$ = emissions factor (EF) corresponding to tabulated speed below the average link speed,

$EF_{HighSpeed}$ = EF corresponding to tabulated speed above the average link speed, and

FAC_{Interp} = $(1/Speed_{link} – 1/Speed_{low})/ (1/Speed_{high} – 1/Speed_{low})$

Given that:

$EF_{LowSpeed}$ = 0.7413 g/mi;

$EF_{HighSpeed}$ = 0.7274 g/mi;

$Speed_{lnk}$ = 41.2 mph;

$Speed_{low}$ = 40 mph; and

$Speed_{high}$ = 45 mph.

FAC_{Interp} = (1/41.2mph – 1/40mph)/ (1/45mph– 1/40mph) = 0.26214

EF_{Interp} = 0.7413 g/mi - (0.26214) × (0.7413 g/mi - 0.7274 g/mi) = 0.7377 g/mi.