Development of Transportation Air Quality Planning Tool for Transportation Agencies

Final Report

by

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16. Abstract

This report presents the development of a comprehensive air quality planning tool designed to enhance the capabilities of transportation agencies in evaluating and mitigating vehicular emissions. Transportation activities are a source of air pollution and greenhouse gas emissions, impacting public health and contributing to climate change. Despite various strategies implemented by federal and state transportation agencies through programs like the Congestion Mitigation and Air Quality Improvement (CMAQ) Program, current tools for assessing the environmental benefits of transportation projects often lack comprehensive coverage, user-friendliness, and up-to-date data, limiting their effectiveness. To address these shortcomings, this project proposes the creation of an Excel-based air quality assessment tool that integrates the latest advancements in emission modeling, including updates to the MOVES (Motor Vehicle Emission Simulator) model. The tool aims to be accessible to non-specialists, enabling state and local transportation agencies to conduct precise and consistent evaluations of proposed projects. It covers a wide range of project types and incorporates user-friendly features to standardize the assessment process, ensuring that CMAQ-funded initiatives achieve maximum air quality benefits. The report details key areas of development, including the preparation of vehicle emission rates using the MOVES model, functionality of specific calculators tailored to projects such as Electronic Open-Road Tolling (EORT), telework programs, transit bus upgrades, and fleet expansions. Additionally, the report provides practical application guidelines and user instructions to ensure effective use of the tool. By accommodating all eligible transportation project types and integrating the latest emission modeling advancements, the tool provides a robust framework for air quality management, supporting better regulatory compliance, environmental protection, and sustainable development goals. Ultimately, this project aims to improve air quality assessments, ensure more effective allocation of CMAQ funds, and enhance environmental quality across various regions, contributing to a cleaner and healthier environment aligned with broader policy objectives.

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EXECUTIVE SUMMARY

This report details the development of a comprehensive air quality planning tool designed to enhance the capabilities of transportation agencies in evaluating and mitigating vehicular emissions. Transportation activities are a source of air pollution and greenhouse gas emissions, contributing to public health issues and climate change. Federal and state transportation agencies, through initiatives like the Congestion Mitigation and Air Quality Improvement (CMAQ) Program, have implemented various strategies to address these challenges. Despite these efforts, the tools currently available for assessing the environmental benefits of transportation projects often lack comprehensive coverage, user-friendliness, and up-to-date data, limiting their effectiveness.

To address these shortcomings, this project proposes the creation of an Excel-based air quality assessment tool that integrates the latest advancements in emission modeling, including updates to the MOVES (Motor Vehicle Emission Simulator) model. The tool aims to be accessible to non-specialists, enabling state and local transportation agencies to conduct precise, consistent evaluations of proposed projects. It covers a wide range of project types and incorporates user-friendly features to standardize the assessment process, ensuring that CMAQ-funded initiatives achieve maximum air quality benefits.

The report outlines the development of this tool in several key areas:

1. Vehicle Emission Rate Preparation: Utilizing the MOVES model, the tool prepares emission rates for various vehicle types, fuel types, and operating conditions. This ensures that the latest data and methodologies are used in emission calculations.
2. Functionality of Specific Calculators: The tool includes several calculators tailored to specific transportation projects, such as Electronic Open-Road Tolling (EORT), telework programs, transit bus upgrades, and fleet expansions. Each calculator estimates the reduction in emissions resulting from these projects, providing detailed insights into their environmental impact.
3. Practical Application and User Guidance: The report provides step-by-step instructions for using the tool, including examples of how to input data and interpret results. This ensures that users can effectively apply the tool to their specific needs and scenarios.
4. Comprehensive Coverage and Accessibility: By accommodating all eligible transportation project types and integrating the latest emission modeling advancements, the tool provides a robust framework for air quality management. Its user-friendly design ensures that it can be used by personnel without specialized training in emissions modeling.

The anticipated outcomes of this project include improved air quality assessments, more effective allocation of CMAQ funds, and enhanced environmental quality across various regions. By providing reliable, accessible, and up-to-date tools for air quality assessment, this project supports better regulatory compliance, environmental protection, and sustainable development goals. Ultimately, the tool aims to contribute to a cleaner, healthier environment, aligning with broader policy objectives and addressing the critical need for effective transportation air quality management.

CHAPTER 1

Introduction and Background

Transportation activities contribute to air pollution and greenhouse gas emissions in the United States, impacting both public health and climate change. Recognizing this, federal and state transportation agencies have deployed various initiatives aimed at mitigating these emissions. A cornerstone of these efforts is the Congestion Mitigation and Air Quality Improvement Program (CMAQ), established under the Clean Air Act Amendments of 1990 (*Puckett et al.*, 2015; *Adler et al.*, 1998). CMAQ targets air quality improvements in areas that fail to meet the National Ambient Air Quality Standards (NAAQS) for pollutants such as ozone and particulate matter. With a substantial budget of $2.6 billion in 2023, CMAQ supports a range of projects designed to reduce vehicular emissions and alleviate congestion, thereby enhancing air quality in underperforming regions.

Despite the proactive stance of these programs, state and local transportation agencies often face challenges in uniformly evaluating the environmental benefits of proposed projects. The process to secure CMAQ funding requires that applicants not only propose but also substantiate the air quality benefits of their projects, demanding a high level of precision and consistency in the assessment methods used. This necessity arises amidst a backdrop where the actual assessment tasks fall predominantly on applicants, who may lack the necessary software, expertise, and resources to effectively model emissions. Moreover, once proposals are submitted, CMAQ reviewers frequently encounter limited information on the methodologies and data underpinning these emissions calculations, increasing the risk of inconsistent funding decisions and potentially undermining the program's objectives.

A issue with the current tools available for air quality evaluation is their failure to cover the full spectrum of project types eligible for CMAQ funding. Many existing tools were developed prior to recent updates, such as the 2014 revision of the MOVES model, resulting in outdated emissions rates and other critical data (*Vallamsundar and Lin*, 2011). This discrepancy is compounded by the tools' generally complex and non-user-friendly nature, which hinders their regular update and maintenance by non-specialist staff at the relevant agencies.

In response to these challenges, this project proposes the development of a new Excel-based air quality assessment tool. This tool aims to be both accessible and comprehensive, capable of accommodating all eligible transportation project types and integrating the latest advancements in emission modeling. By enhancing the precision and ease of air quality evaluations, the tool seeks to standardize assessments across various proposals, ensuring that the benefits of funded projects are maximized and contribute effectively to national air quality goals. This approach supports the practical needs of state and local agencies and aligns with broader environmental policy objectives, aiming to provide a robust framework for sustainable transportation planning.

CHAPTER 2

Literature Review

Transportation is a contributor to air pollution, directly impacting ambient air quality and public health. The sector is responsible for substantial nitrogen oxides, particulate matter, and volatile organic compounds emissions. These pollutants contribute to respiratory diseases, cardiovascular problems, and environmental issues such as acid rain and global warming. Transportation emissions' complexity stems from many sources, including combustion engines in vehicles and indirect sources such as road dust and tire wear. Urban growth increases reliance on motor vehicles, exacerbating pollution levels and highlighting the urgent need for effective emission controls.

Various models and tools have been developed to assess and quantify emissions from transportation. These include spreadsheet models for quick assessments and more complex simulation tools for detailed analysis:

- EMFAC – Used in California, it calculates emissions from on-road vehicles, helping the state meet its air quality goals (*Bai et al.*, 2009).
- COPERT – This European tool is used to create emission inventories and provide data that help in policy-making and environmental planning (*Ntziachristos et al.*, 2009).
- HBEFA – Deployed across Europe, offers detailed emission factors by road type and driving conditions and is widely used for environmental impact assessments (*Colberg et al.*, 2005).

While these tools are instrumental in emission analysis, they often require specific data and technical know-how, which can limit their use to specialists, hindering broader application in early-stage planning by non-experts.

The EPA's Motor Vehicle Emission Simulator (MOVES) is a state-of-the-art emissions modeling tool designed to estimate air pollution emissions, including criteria air pollutants, greenhouse gases, and air toxics (Assessment and Standards Division, U.S. EPA, 2023). It provides detailed emissions estimates from road transportation, considering various vehicle types, fuel types, and operating conditions. MOVES supports emissions estimation at multiple scales—from national inventories to specific project analyses—making it invaluable for policy evaluation and localized environmental planning.

MOVES is continually updated to reflect the latest in-vehicle technologies, fuel formulations, and regulatory standards, making it the state-of-the-art tool in the transportation emissions domain. Its ability to model emissions at granular levels allows for accurate planning and compliance with national air quality standards, addressing both broad and localized environmental impacts.

Despite the availability of advanced tools like MOVES, there is a gap in their practical integration into everyday planning processes by state and local transportation agencies. There is a strong demand for tools that are accurate, adaptable, and easy to use for personnel without specialized training in emissions modeling. An Excel-based tool that combines the robustness of MOVES with user-friendly features could enhance the capabilities of these agencies. Such a tool would promote uniformity in proposal evaluations and ensure equitable funding allocation towards projects with maximum air quality benefits.

The development of accessible, accurate, and practical tools for transportation air quality assessment is critical in supporting the efforts of transportation agencies to improve air quality. By bridging the gap with updated methodologies and user-friendly functionalities, these tools can effectively enhance air quality management across various regions, leading to better health outcomes and environmental quality.

CHAPTER 3

Simulation and Data Preparation

This chapter discusses the preparation of vehicle emission rates using the MOVES (Motor Vehicle Emission Simulator) model. We used MOVES to project emissions from 2023 to 2030, with the resulting data stored in a database for analysis and strategic planning. This section details the procedure for running MOVES, using 2025 as an example, including screenshots and explanations for each step.

Introduction to MOVES Model Runs

Running the MOVES model involves key steps tailored to specific needs. Its flexibility allows for emissions data generation across various scenarios, including future projections. By adjusting variables, users can simulate the impact of changes in vehicle types, fuel usage, technology, and regulations on emissions.

Running MOVES for the Year 2025: A Step-by-Step Guide

3.1 Step 1: Scale Setup

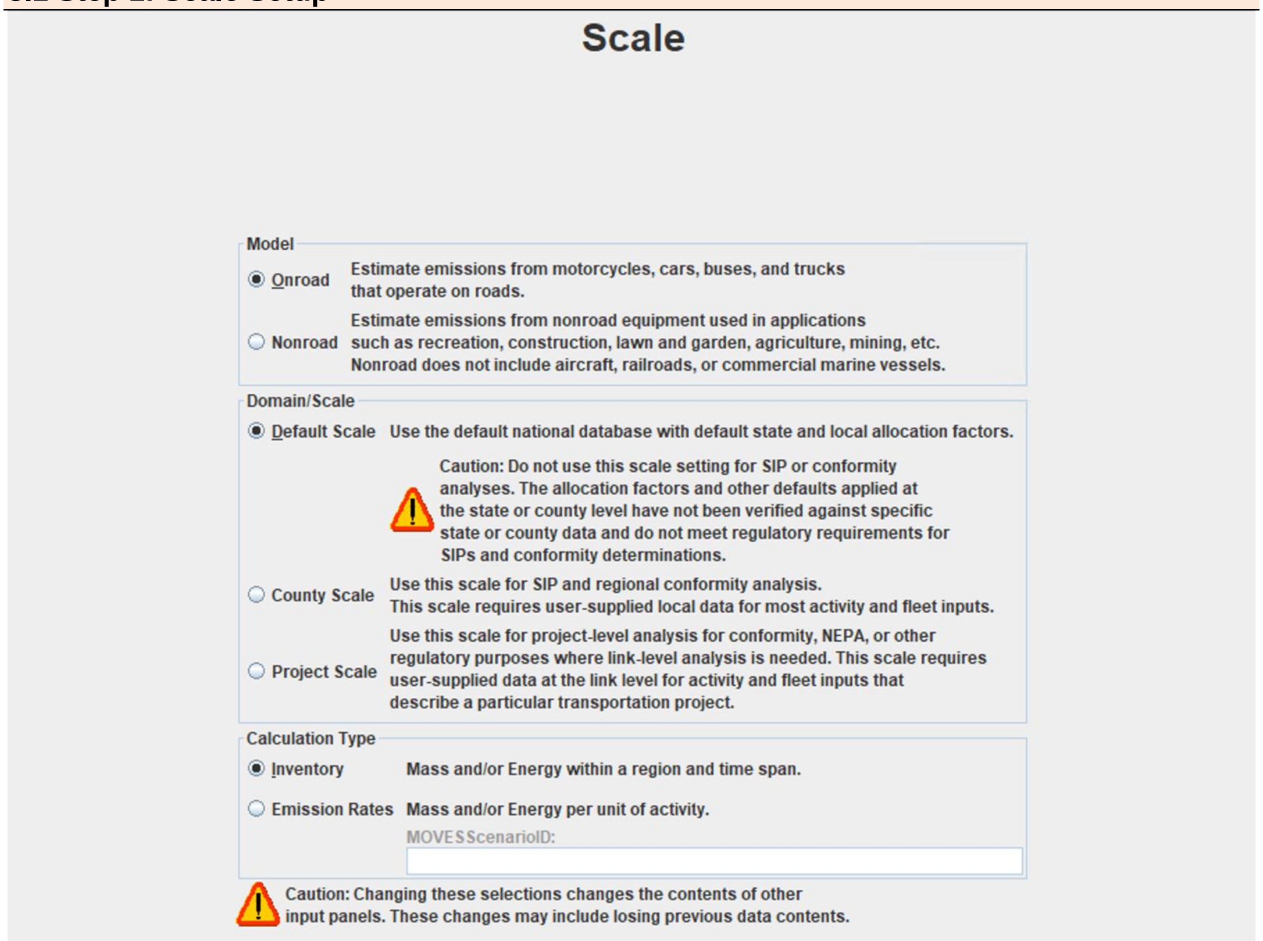


Figure 1: Scale Setup

Scale Selection:
- Model: Onroad
  - Reason for Selection: This is selected to focus on vehicles that operate on roads, such as cars, trucks, and buses, which are directly relevant to urban traffic emissions and the typical subjects of air quality management in urban planning.

- Domain/Scale: Default Scale
  - Reason for Selection: The Default Scale utilizes the U.S. Environmental Protection Agency's MOVES National Scale Database, which includes state and local allocation factors. This database combines vehicle activity data, such as vehicle miles traveled (VMT), age distributions, and fuel usage patterns, from national surveys and regional inputs. It ensures a consistent and reliable baseline for emissions analysis while incorporating regional variations. This choice simplifies the setup process by using pre-established data, which is ideal for broad assessments where regional specificity is less critical. It balances detail and usability, which is especially useful for general emissions inventories that aid in national or state-level planning and compliance.

- Calculation Type: Inventory
  - Reason for Selection: Choosing Inventory allows calculating total emissions within a specified region and timeframe. This is essential for compiling comprehensive emissions inventories, useful in regulatory reporting, environmental policy development, and evaluating the overall impact of on-road vehicles on air quality.

These settings in the MOVES model are strategically chosen to provide a broad overview of emissions, facilitating assessments that help formulate or adjust air quality management strategies at a macro level.

3.2 Step 2: Time Spans Selection

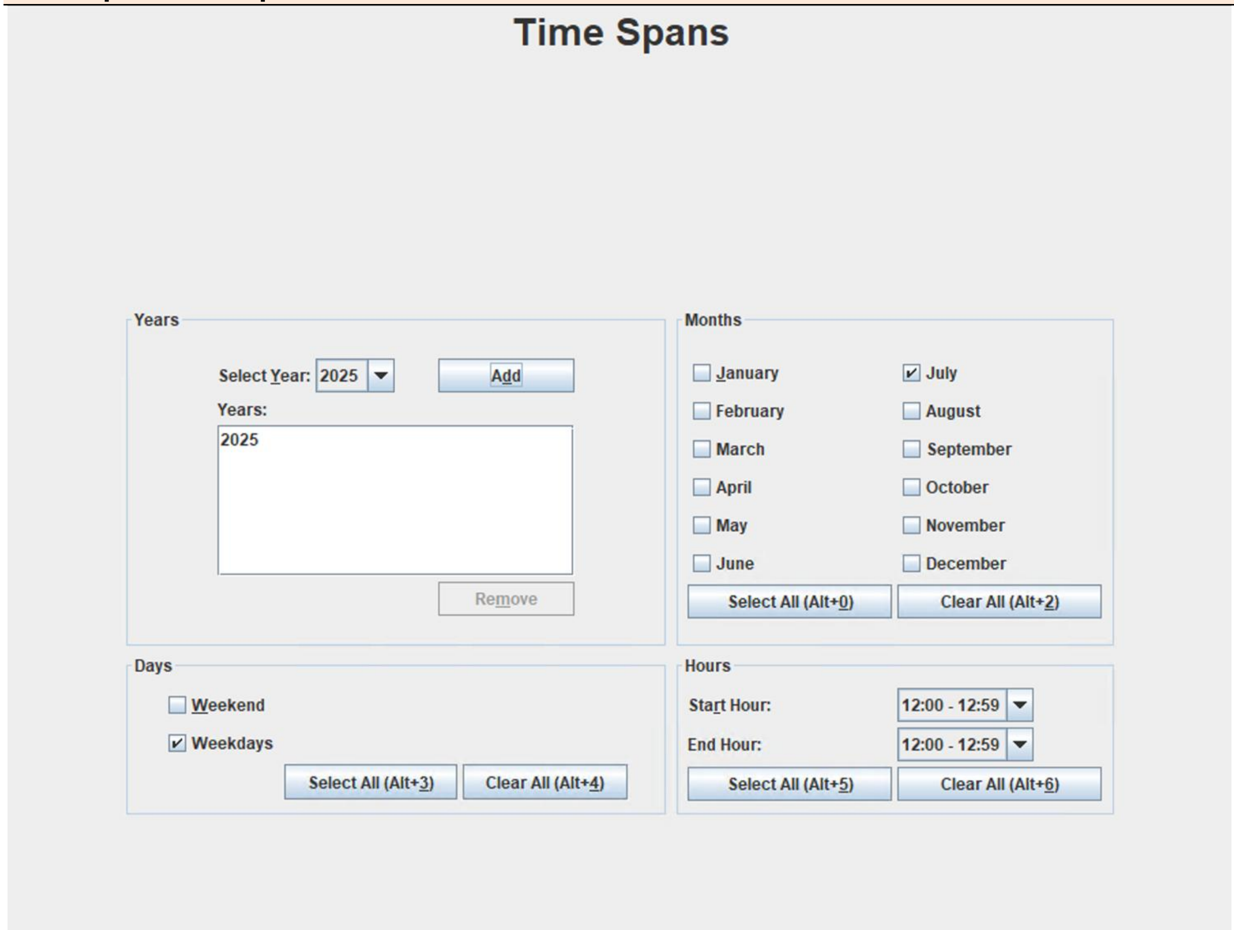


Figure 2: Time Spans Selection

Time Span Settings:
- Years: 2025
  - Reason for Selection: Choosing the year 2025 targets the emissions estimates specifically for this future year, providing insights into the expected air quality impacts based on current and projected vehicle usage and regulations. This is essential for planning and aligning with strategic goals or regulatory compliance requirements set for this period.

- Months: July
  - Reason for Selection: Selecting July allows for focusing on a summer month which typically has higher ozone levels and can experience different traffic patterns due to seasonal changes. This helps understand the worst-case scenarios for smog and ozone buildup, which is critical for air quality management during peak pollution months.

- Days: Weekdays
  - Reason for Selection: Focusing on weekdays accounts for regular commuting patterns, capturing most vehicular emissions during the business week. This choice is important for accurately estimating emissions during peak traffic times, providing a realistic view of daily emissions influences.

- Hours: 12:00 - 12:59 PM
  - Reason for Selection: Narrowing the simulation to the noon hour can be strategic for analyzing emissions during midday traffic, which might include a mix of lunchtime personal travel and commercial transportation. This hour often captures a different dynamic than rush hours, potentially highlighting midday peak emissions.

This setup in the MOVES model allows for a focused analysis of emissions during specific times when traffic patterns and vehicle usage might impact air quality. The simulation can offer detailed insights into emission trends and peak pollution periods by choosing a specific month, day type, and hour, aiding in targeted air quality improvement strategies.

3.3 Step 3: Geographic Bounds Selection

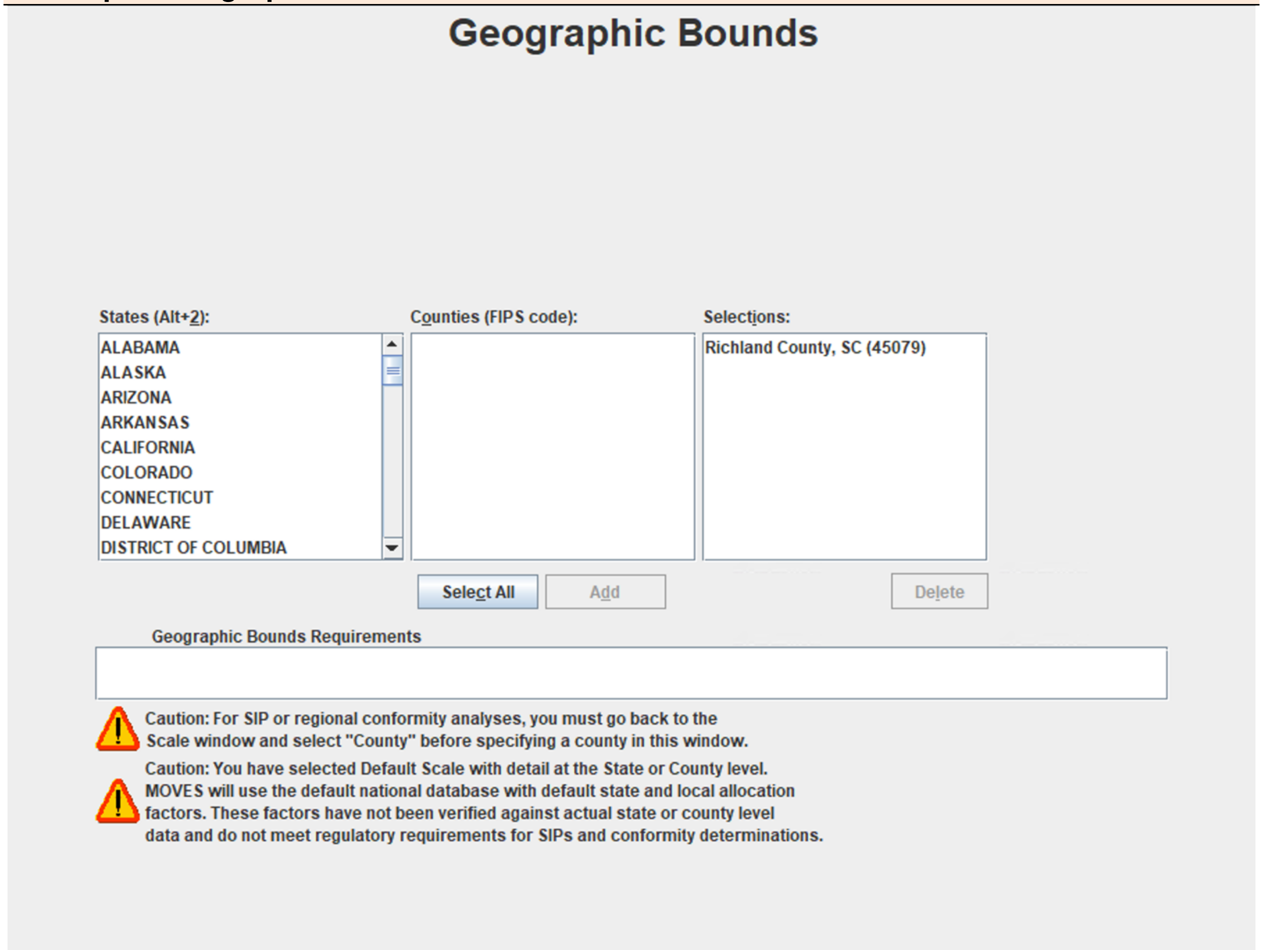


Figure 3: Geographic Bounds Selection

Geographic Bounds Settings:
- Selected County: Richland County, SC
  - Reason for Selection: Choosing Richland County, SC, targets the emissions estimation to this area, allowing for localized analysis of vehicle emissions. This is crucial for addressing regional air quality management challenges specific to Richland County. The focus on a single county ensures that the data and results directly apply to local transportation planning and air quality improvement initiatives.

Details:
- By specifying Richland County, SC, the MOVES model will use detailed, county-specific data such as vehicle types prevalent in the area, local driving patterns, and county-specific vehicle emissions factors. This precision helps generate more accurate emissions inventories and forecasts tailored to the local environment and regulatory needs.

- Importance of Localized Analysis: Focusing on a specific geographic area allows stakeholders to develop and evaluate air quality strategies that are most effective for that region. For Richland County, this could involve examining the impact of local traffic congestion, the effects of regional transportation policies, or the benefits of proposed air quality improvement measures such as increasing public transit availability or expanding EV infrastructure, including installing electric vehicle charging stations, incentivizing EV adoption through subsidies, and integrating EVs into public and private transportation fleets. These efforts can significantly reduce vehicle emissions, improve air quality, and support long-term sustainability goals.

This setup within the MOVES model facilitates a targeted approach to emissions modeling, providing detailed insights essential for effective local air quality management and policymaking.

3.4 Step 4: Onroad Vehicles Selection

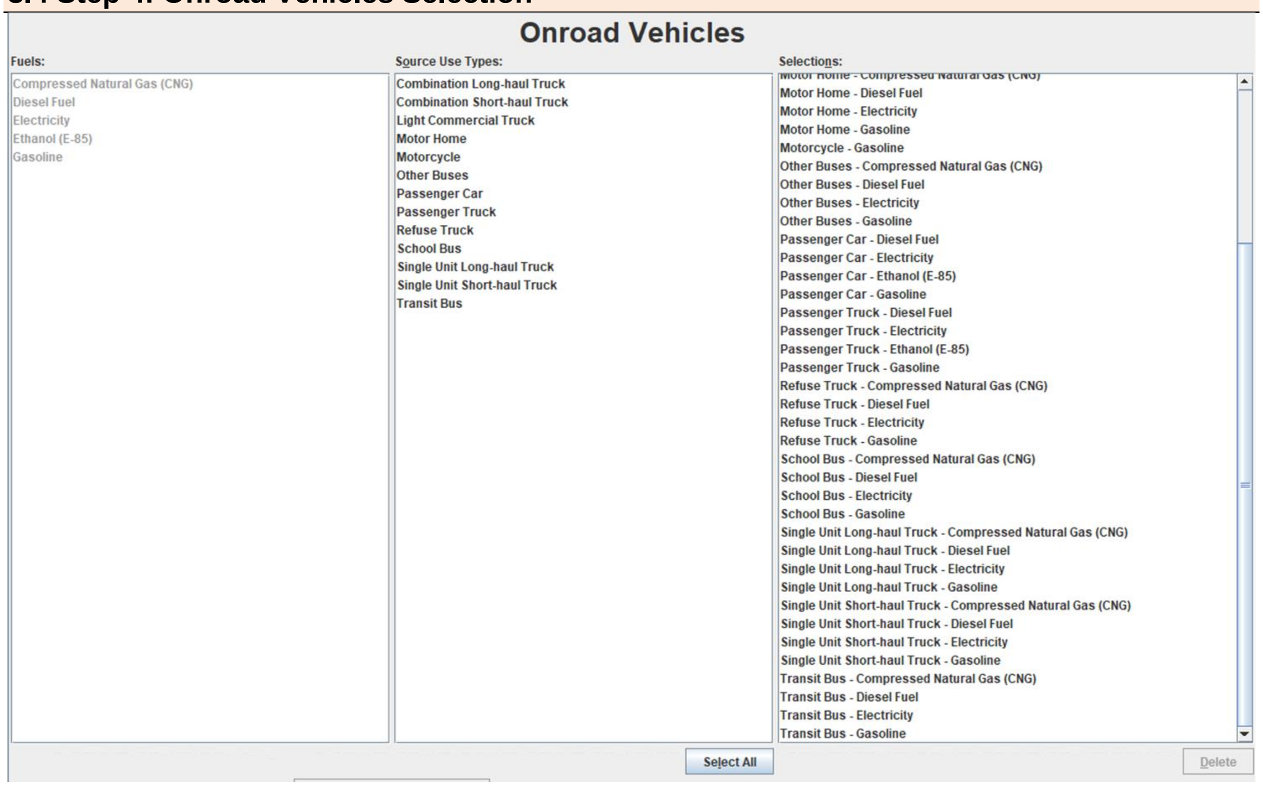


Figure 4: Onroad Vehicles Selection

Onroad Vehicles Settings:
- All Source Use Types Selected:
  - Selection includes all vehicle types listed, from passenger cars and motorcycles to various types of trucks and buses, each with different fuel types, including gasoline, diesel, electricity, and compressed natural gas (CNG).

Reason for Selection:
- Comprehensive Analysis: By selecting all source use types, the MOVES model is configured to include a wide variety of onroad vehicles in the emission simulation. This comprehensive approach ensures that the emission estimates capture all potential sources of vehicular emissions within the specified geographic area (Richland County, SC in this case).

- Diverse Vehicle Dynamics: Different vehicle types and their respective fuel usages impact emission profiles. Including all vehicle types allows for detailed emission inventory across different segments, crucial for accurate air quality management and planning.

- Versatility in Data Output: This setup provides versatility in analyzing emissions across various vehicle categories, facilitating targeted strategies for emission reduction based on specific vehicle types or fuel-related emissions.

Example:
- Scenario: The complete range of selected vehicles will enable Richland County to assess which vehicle types contribute most to NOx and PM emissions during peak and off-peak hours. For instance, heavy-duty trucks might dominate NOx emissions, whereas passenger cars could be major contributors to CO2 levels.

This setup allows for detailed emissions analysis and supports informed decision-making regarding air quality improvement strategies tailored to local needs. By encompassing all types of onroad vehicles, stakeholders can develop more effective policies that address the specific characteristics and impacts of different vehicle sectors.

3.5 Step 5: Road Type Selection

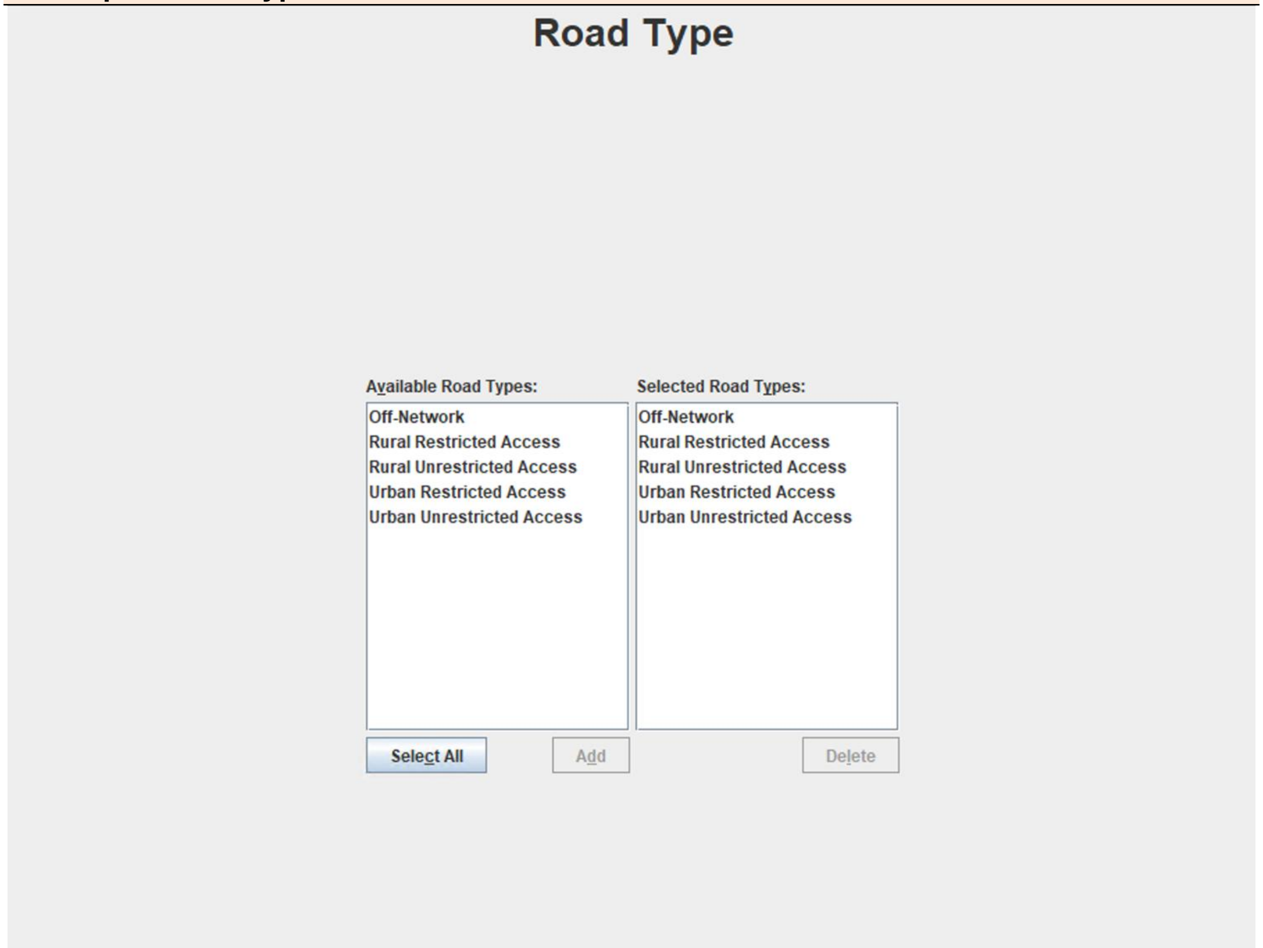


Figure 5: Road Type Selection

Road Type Settings:
- Selected Road Types: All available types have been selected, which include:
  - Off-Network
  - Rural Restricted Access
  - Rural Unrestricted Access
  - Urban Restricted Access
  - Urban Unrestricted Access

Reason for Selection:
- Comprehensive Coverage: Selecting all available road types allows the simulation to encompass every possible driving environment within the specified geographic area. This inclusive approach ensures no potential emission sources are overlooked, capturing a full spectrum of traffic conditions and road types.

- Diverse Traffic Dynamics: Different road types experience varying levels of traffic density, speed limits, and vehicle types. Including all road types in the model provides a nuanced view of emissions across different traffic scenarios, from high-speed rural highways to congested urban streets.

- Enhanced Accuracy in Emission Estimation: By including every road type, the model can more accurately calculate emissions that reflect real-world driving patterns across diverse roadway environments. This accuracy is crucial for developing effective air quality management strategies that target specific areas and conditions where emission reductions are most needed.

Example:
- Scenario: By analyzing emissions across all road types, Richland County can identify specific road types where emission reductions could be most effective. For instance, targeted interventions on urban unrestricted access roads might be prioritized if they are found to contribute disproportionately to peak hour emissions.

This setup ensures that the emission estimates are comprehensive and reflective of actual driving conditions, aiding in the detailed assessment and management of air quality based on localized traffic dynamics and environmental impact.

3.6 Step 6: Pollutants and Processes Selection

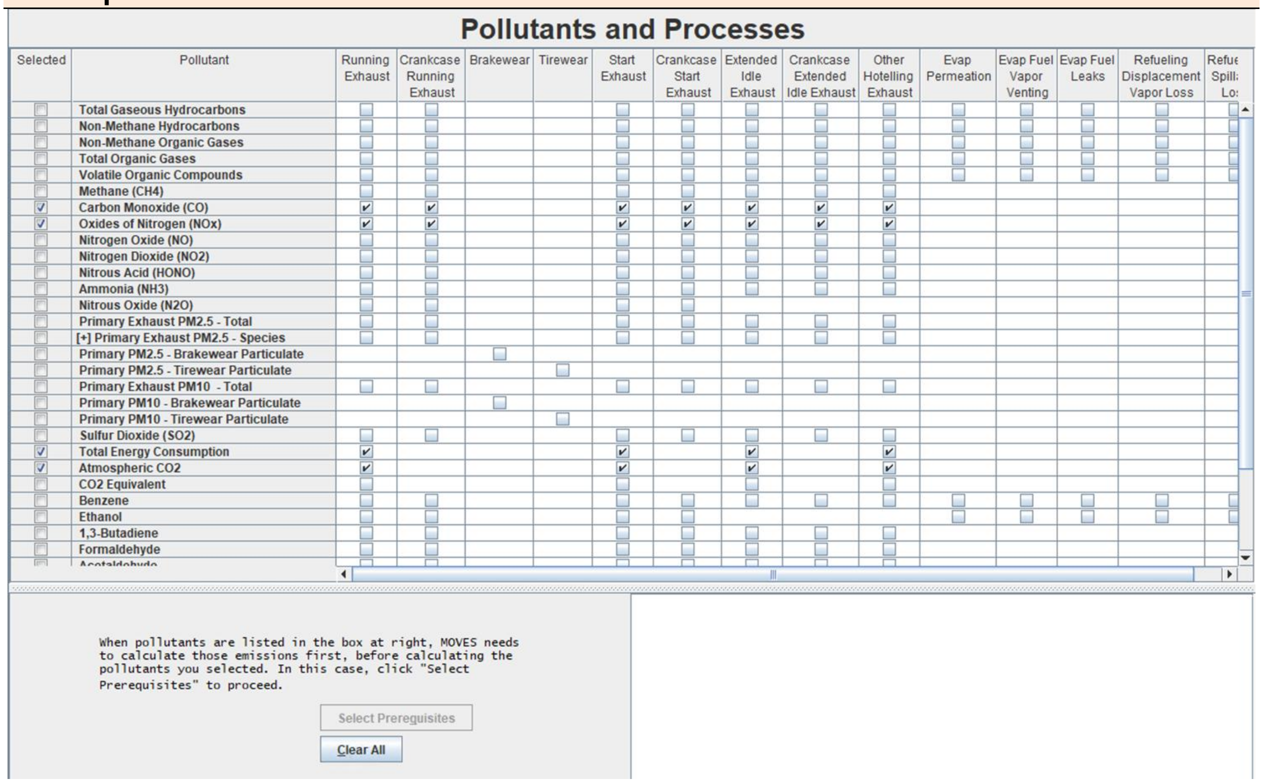


Figure 6: Pollutants and Processes Selection

Pollutants Selected:
- Carbon Monoxide (CO)
  - Reason for Selection: Carbon Monoxide is a primary pollutant of concern in urban areas due to its harmful health effects and prevalence in vehicle exhaust. Selecting CO allows for assessing the impact of vehicular traffic on urban air quality and public health.

- Oxides of Nitrogen (NOx)
  - Reason for Selection: NOx contributes to ground-level ozone and smog formation. Evaluating NOx emissions is crucial for air quality management, especially in urban areas where dense traffic and NOx can impact respiratory health.

- Atmospheric CO2
  - Reason for Selection: CO2 is vehicles' principal greenhouse gas emitted through fossil fuel combustion. Including Atmospheric CO2 in the simulation is essential for understanding the broader impacts of transportation on climate change.

- Total Energy Consumption
  - Reason for Selection: This metric provides insight into the overall energy efficiency of the vehicle fleet. Monitoring Total Energy Consumption helps evaluate the effectiveness of policies that reduce energy use and transition to more sustainable energy sources.

Processes Involved:
- The selected pollutants involve various processes, including tailpipe emissions during running and idling, as well as the broader implications for energy use and greenhouse gas emissions. This comprehensive approach ensures that all relevant emission factors and activities are considered for a holistic assessment.

Example:
- Scenario: In a study on improving air quality in Richland County, SC, selecting these specific pollutants will help local environmental agencies develop targeted strategies. For example, strategies might focus on reducing CO emissions through enhanced vehicle inspections, curbing NOx emissions via traffic flow improvements, and promoting electric vehicle use to reduce CO2 emissions and total energy consumption.

By selecting these key pollutants and associated processes, the MOVES model is tailored to provide detailed insights into the most critical aspects of vehicular emissions that affect urban air quality, public health, and energy usage. This setup supports strategic decision-making for environmental policy and air quality management.

3.7 Step 7: General Output Selection

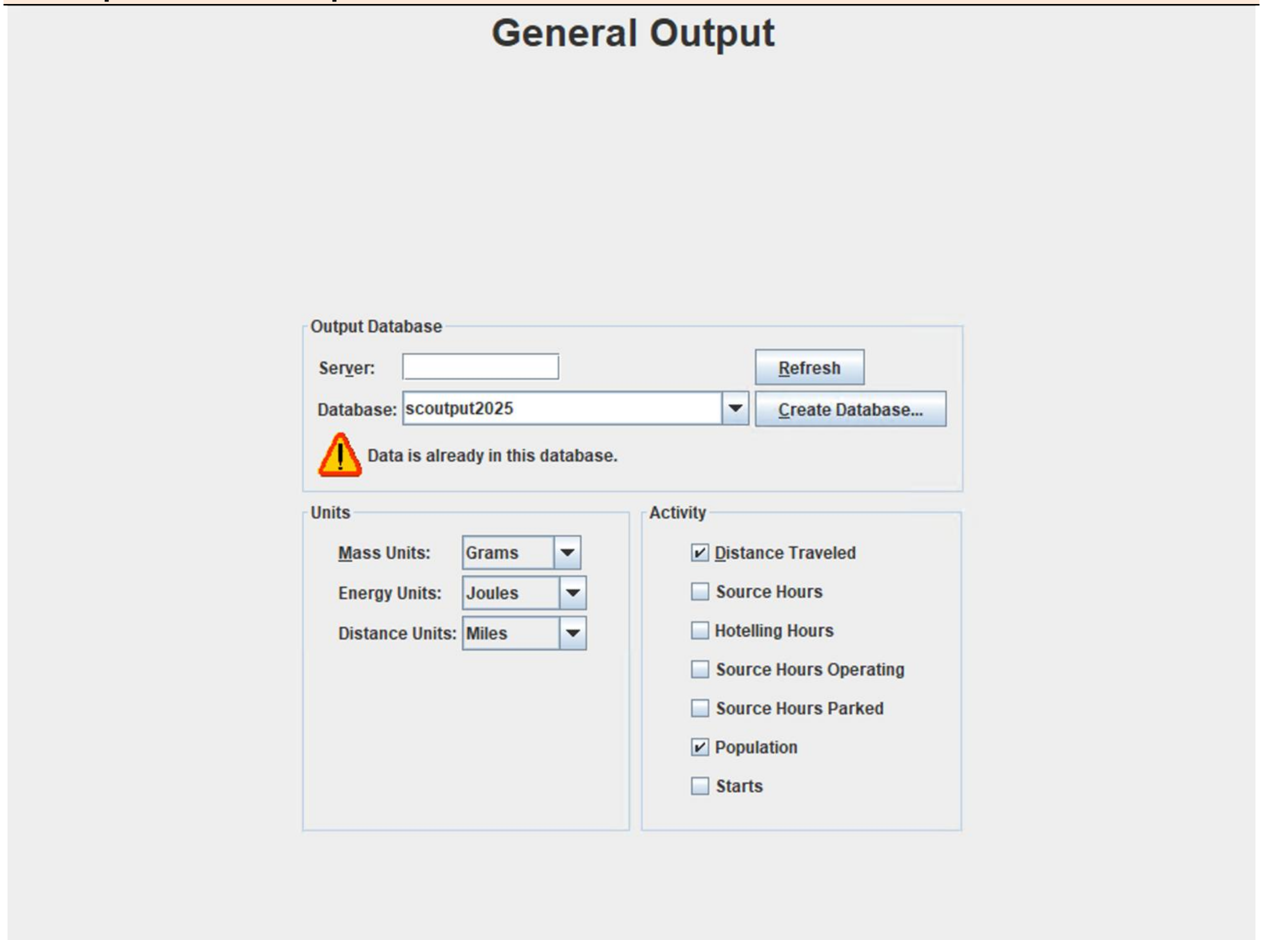


Figure 7: General Output Selection

General Output Settings:
- Database Name: `scoutput2025`
  - Reason for Selection: The database name `scoutput2025` specifies that this output will store data specifically for South Carolina for the year 2025. This naming convention helps efficiently organize and retrieve model outputs for future reference and analysis.

- Units:
  - Mass Units: Grams
    - Reason for Selection: Grams are a standard unit for measuring small quantities of emissions, allowing for precise calculations and comparisons across different pollutants.
  - Energy Units: Joules
    - Reason for Selection: Joules are used to measure energy; providing a standard unit that aligns with international scientific measures is useful for calculating energy consumption and emissions in energy-related studies.
  - Distance Units: Miles
    - Reason for Selection: Miles are commonly used in the United States for transportation measures, making this unit appropriate for local and national traffic and emissions studies.

- Activity:
  - Distance Traveled
    - Reason for Selection: This metric is crucial for correlating emissions directly with the amount of vehicle operation, providing a foundational measure for all transportation emissions studies.
  - Population
    - Reason for Selection: Including population activity data helps estimate emissions per capita or per vehicle, offering insights into emissions efficiency and providing a basis for demographic-related emissions planning.

Example:

- Scenario: By setting up the output in the MOVES model with these specific parameters, stakeholders can effectively analyze how different vehicle types contribute to total emissions in South Carolina in 2025. For instance, they can determine the emissions impact per mile traveled for different vehicle categories or understand the variations in emissions relative to population density and vehicle usage patterns.

This setup ensures that the emission modeling and output are tailored to the project's specific needs, providing detailed and usable data for environmental planning and policymaking. By configuring the database and units accurately, the output data will be ready for comprehensive analysis to inform state-level or local transportation and environmental strategies.

3.8 Step 8: Output Emissions Detail Selection

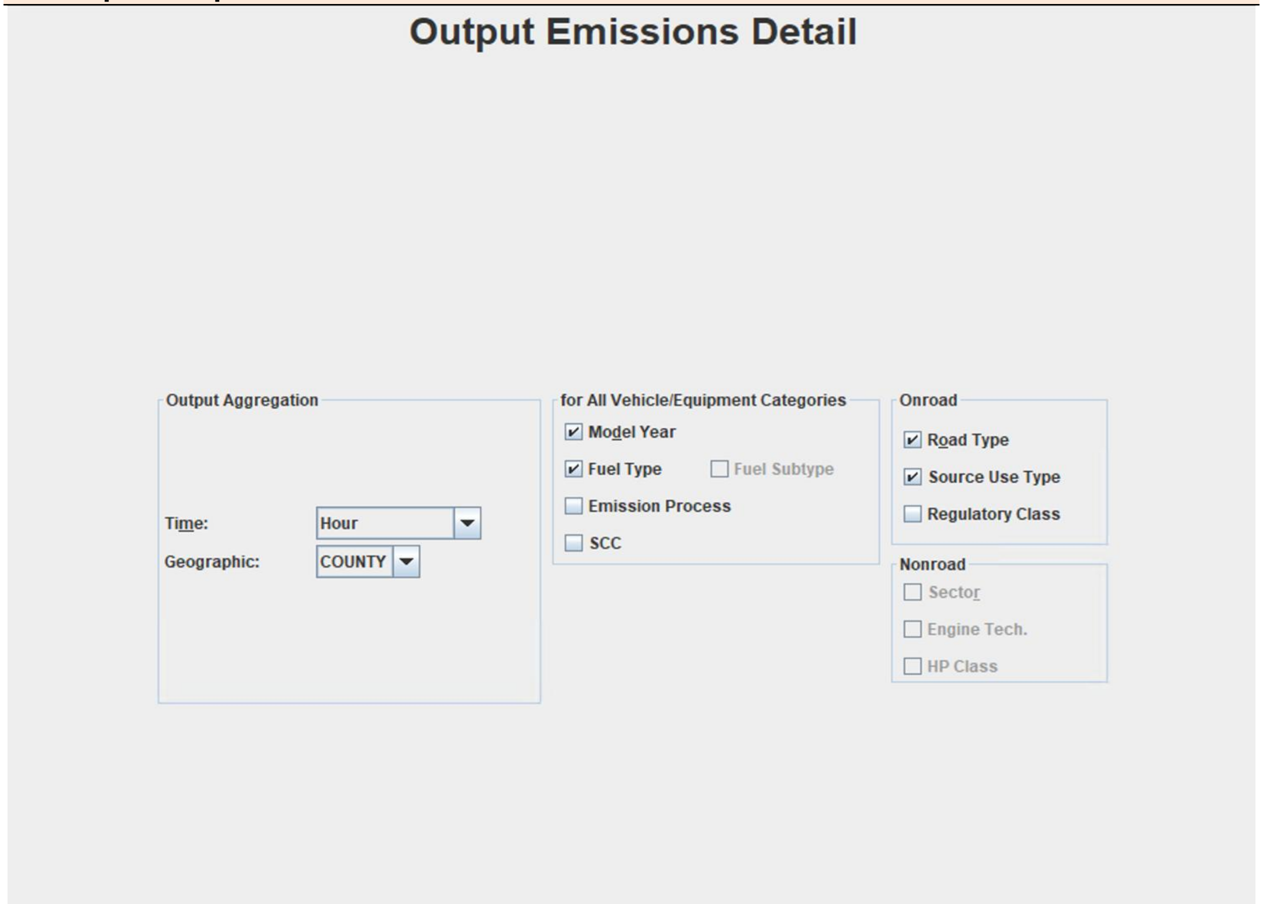


Figure 8: Output Emissions Detail Selection

Output Aggregation Settings:
- Time: Hour
  - Reason for Selection: Choosing hourly output provides detailed temporal resolution for emissions data, which is crucial for understanding peak emission hours and assessing hourly variations in air quality.

- Geographic: County
  - Reason for Selection: Aggregating data at the county level aligns with the geographic focus of the simulation (Richland County, SC), allowing for localized analysis and targeted air quality management within that specific area.

For All Vehicle/Equipment Categories Settings on the Onroad Tab:
- Model Year
  - Reason for Selection: Including model year in the output helps differentiate emissions based on vehicle age, which is important for analyzing trends over time and the impact of newer, more efficient vehicles entering the fleet.

- Fuel Type
  - Reason for Selection: Differentiating emissions by fuel type is essential to identify which fuels contribute most to pollution and to evaluate the effectiveness of policies promoting cleaner alternative fuels.

- Road Type
  - Reason for Selection: Selecting road type provides insights into where emissions are highest, whether on urban or rural roads, and helps plan specific interventions like traffic management or road upgrades.

- Source Use Type
  - Reason for Selection: Including source use type allows the analysis to be broken down by vehicle usage characteristics, such as passenger cars, trucks, and buses, offering detailed data for specific vehicle classes and their impact on overall emissions.

This configuration ensures the emissions output is detailed and specific, providing rich data for in-depth analysis and decision-making. By focusing on these detailed categories, stakeholders can more effectively design and implement strategies to reduce emissions at the most critical times and locations, as well as for the most impactful vehicle types and uses.

3.9 Step 9: Advanced Features Selection

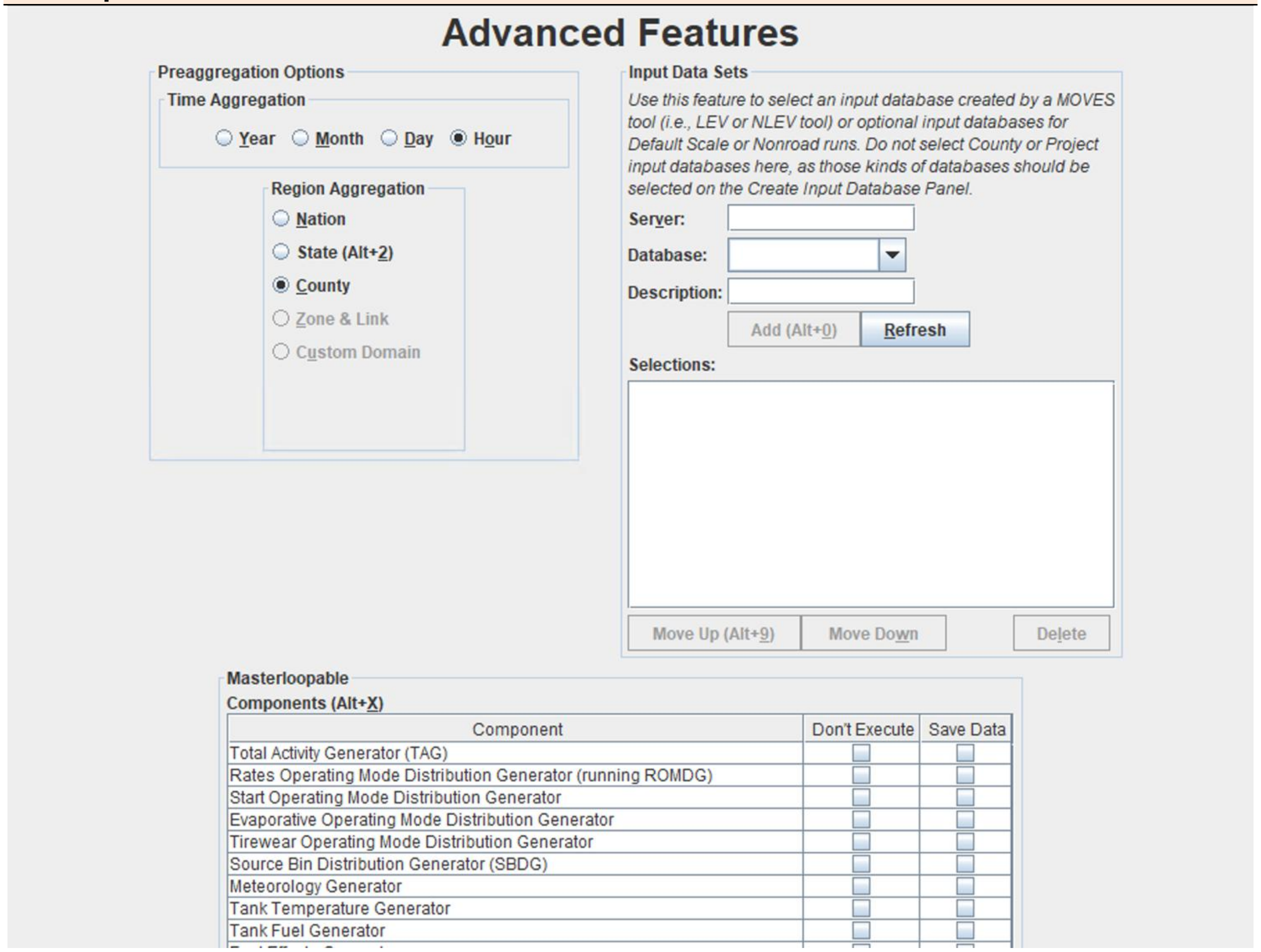


Figure 9: Advanced Features Selection

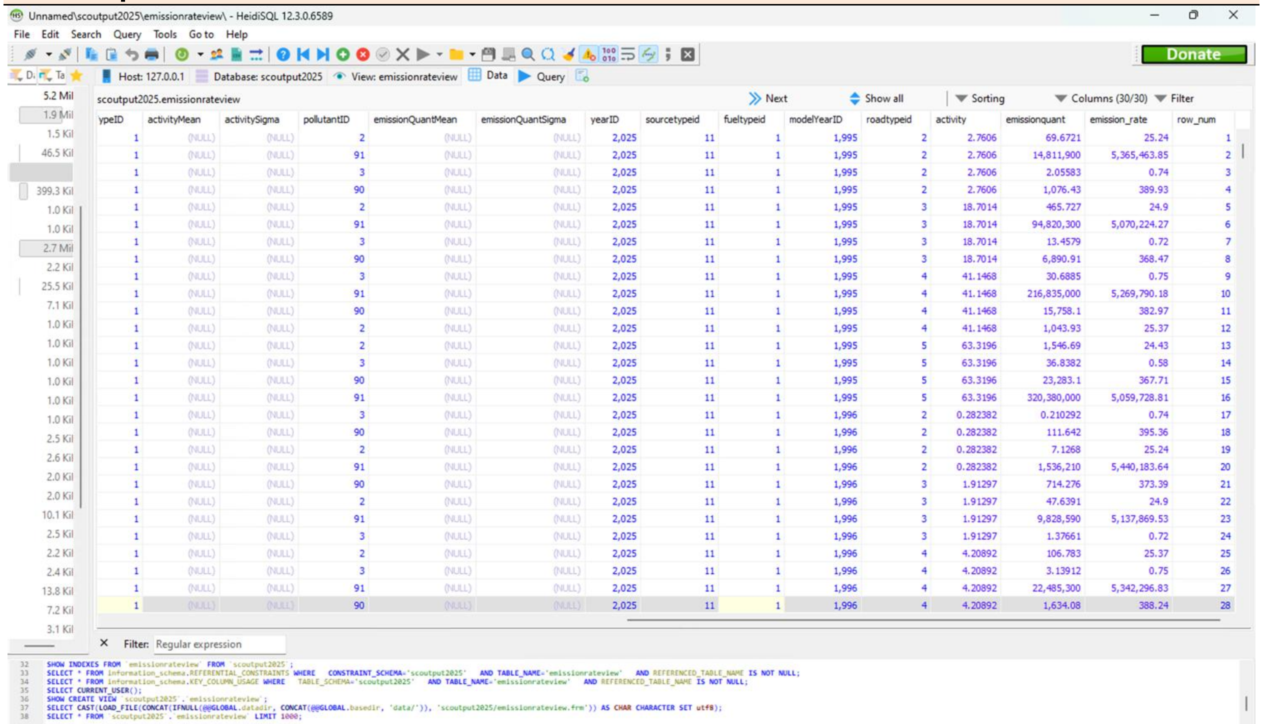
Advanced Features Settings:
- Time Aggregation: Hour
  - Reason for Selection: Choosing 'Hour' as the time aggregation level allows for a detailed analysis of emissions fluctuations within a day. This granularity is crucial for identifying peak emission hours and understanding daily emission patterns, which can inform targeted traffic management and pollution control strategies.

- Region Aggregation: County
  - Reason for Selection: Selecting 'County' for region aggregation focuses the emissions analysis on a specific county level, providing localized insights essential for county-specific air quality management plans. This detailed geographic focus helps in addressing specific local environmental challenges effectively.

Example:
- Scenario: In a detailed air quality study for Richland County, analyzing emissions on an hourly basis helps pinpoint when interventions might be most needed, such as during morning or evening rush hours. Similarly, focusing on the county level ensures that the strategies developed are perfectly tailored to the local population's habits and the region's specific air quality issues.

This setup in the 'Advanced Features' section enhances the precision of the emissions modeling process, ensuring that both the temporal and geographic resolutions are aligned with the needs of detailed environmental analysis and strategic planning.

3.10 Step 10: Generate Emission Rate View



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1	(NULL)	(NULL)	91	(NULL)	(NULL)	2,025	11	1	1,995	4	41.1468	216,835,000	5,269,790.18	10
1	(NULL)	(NULL)	90	(NULL)	(NULL)	2,025	11	1	1,995	4	41.1468	15,758.1	382.97	11
1	(NULL)	(NULL)	2	(NULL)	(NULL)	2,025	11	1	1,995	4	41.1468	1,043.93	25.37	12
1	(NULL)	(NULL)	2	(NULL)	(NULL)	2,025	11	1	1,995	5	63.3196	1,546.69	24.43	13
1	(NULL)	(NULL)	3	(NULL)	(NULL)	2,025	11	1	1,995	5	63.3196	36.8382	0.58	14
1	(NULL)	(NULL)	90	(NULL)	(NULL)	2,025	11	1	1,995	5	63.3196	23,283.1	367.71	15
1	(NULL)	(NULL)	91	(NULL)	(NULL)	2,025	11	1	1,995	5	63.3196	320,380,000	5,059,728.81	16
1	(NULL)	(NULL)	3	(NULL)	(NULL)	2,025	11	1	1,996	2	0.282382	0.210292	0.74	17
1	(NULL)	(NULL)	90	(NULL)	(NULL)	2,025	11	1	1,996	2	0.282382	111.642	395.36	18
1	(NULL)	(NULL)	2	(NULL)	(NULL)	2,025	11	1	1,996	2	0.282382	7.1268	25.24	19
1	(NULL)	(NULL)	91	(NULL)	(NULL)	2,025	11	1	1,996	2	0.282382	1,536,210	5,440,183.64	20
1	(NULL)	(NULL)	90	(NULL)	(NULL)	2,025	11	1	1,996	3	1.91297	714.276	373.39	21
1	(NULL)	(NULL)	2	(NULL)	(NULL)	2,025	11	1	1,996	3	1.91297	47.6391	24.9	22
1	(NULL)	(NULL)	91	(NULL)	(NULL)	2,025	11	1	1,996	3	1.91297	9,828,590	5,137,869.53	23
1	(NULL)	(NULL)	3	(NULL)	(NULL)	2,025	11	1	1,996	3	1.91297	1.37661	0.72	24
1	(NULL)	(NULL)	2	(NULL)	(NULL)	2,025	11	1	1,996	4	4.20892	106.783	25.37	25
1	(NULL)	(NULL)	3	(NULL)	(NULL)	2,025	11	1	1,996	4	4.20892	3.13912	0.75	26
1	(NULL)	(NULL)	91	(NULL)	(NULL)	2,025	11	1	1,996	4	4.20892	22,485,300	5,342,296.83	27
1	(NULL)	(NULL)	90	(NULL)	(NULL)	2,025	11	1	1,996	4	4.20892	1,634.08	388.24	28

Figure 10: Generate Emission Rate View

We used SQL to aggregate the data from 2023 to 2030, performed calculations, and obtained an emission rate table. Finally, we imported the emission rate table into an Excel-based tool as the default values.

CHAPTER 4

Feature Selection, Model Development, and Results

4.1 Electronic Open-Road Tolling (EORT)

4.1.1 Functionality

- This calculator will estimate the reduction in emissions from replacing highway toll plaza infrastructure with open-road gantries using electronic tolling (EORT). Users should enter representative traffic conditions before and after conversion to electronic open-road tolling or pay-by-plate technology.

4.1.2 How to Operate

- Input Year, Road Type, Model Years, Fuel Types, and Source Types are used to establish the emission rate. Enter Total Miles at the toll plaza and Emission rate reduction percentage due to electronic tolling for Total Energy, Atmospheric CO2, NOx, and CO.

4.1.3 Results

- Calculates expected reduction in emissions due to decreased traffic congestion and altered travel routes.
- Formula: Old Emission = Total Miles at toll plaza * Emission Rate
New Emission = Total Miles at toll plaza * (1- Traffic Reduction Percentage) * Emission Rate

4.1.4 Example

F5

```
=(B9 * (1-B10) * INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B6) * (RawData!$B$2:$B$133466=B5) * (RawData!$D$2:$D$133466=B7) * ( RawData!$E$2:$E$133466=B8) * (RawData!$F$2:$F$133466="Total Energy"), 0))) / 120000000
```

Input:	
Year	2023
Model Year	2001
Fuel Type	Diesel Fuel
Source Type	Passenger Car
Road type	Urban Restricted Access
Total Miles at toll plaza	1000000
Emission rate reduction percentage due to electronic toll: Total Energy	20%
Emission rate reduction percentage due to electronic toll: Atmospheric CO2	20%
Emission rate reduction percentage due to electronic toll: Nox	20%
Emission rate reduction percentage due to electronic toll: CO	20%

Output:		
Pollutant	Old Emission	New Emission
Total Energy (gasoline gallon equivalent per y	45,153.3	36,122.6
Atmospheric CO2 (ton per year)	401.7	321.4
Nox (ton per year)	0.5	0.4
CO (ton per year)	10.3	8.3

Figure 11: Electronic Open-Road Tolling (EORT)

- In this example, implementing Electronic Open-Road Tolling (EORT) at a toll plaza with an annual traffic volume of 100,000 miles leads to a 20% reduction in emissions due to improved traffic flow and decreased congestion. Using the calculator, emissions for Total Energy decrease from 45,153.3 to 36,122.6 gasoline gallon equivalents per year, Atmospheric CO2 emissions are reduced from 401.7 to 321.4 tons per year, NOx emissions drop from 0.5 to 0.4 tons per year, and CO emissions decrease from 10.3 to 8.3 tons per year.

4.2 Telework Tool

4.2.1 Functionality

- This calculator will estimate the reduction in emissions resulting from telework programs. Note that the calculations in this tool are based on a five-day workweek.

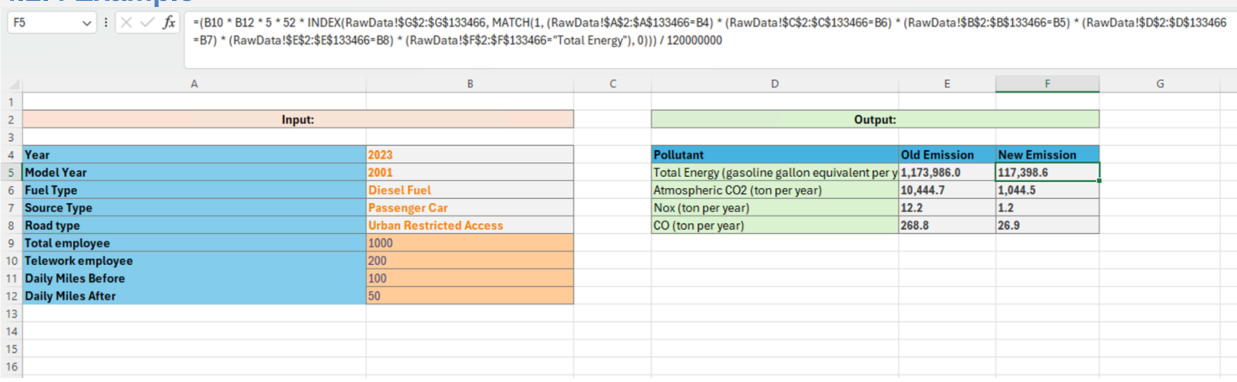
4.2.2 How to Operate

- Input Year, Model Year, Fuel Type, Source Type, and Road type to determine the emission rate. Enter the total number of employees, number of teleworking employees, and daily miles before and after teleworking.

4.2.3 Results

- Outputs potential emissions saved from reduced commuting.
- Formula: Old Emission = Total employee * Daily Miles Before * 5 * 52 * Emission Rate
New Emission = Telework employee * Daily Miles After * 5 * 52 * Emission Rate

4.2.4 Example



F5 =(B10 * B12 * 5 * 52 * INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B6) * (RawData!$B$2:$B$133466=B5) * (RawData!$D$2:$D$133466=B7) * (RawData!$E$2:$E$133466=B8) * (RawData!$F$2:$F$133466="Total Energy"), 0))) / 120000000

Input:	
Year	2023
Model Year	2001
Fuel Type	Diesel Fuel
Source Type	Passenger Car
Road type	Urban Restricted Access
Total employee	1000
Telework employee	200
Daily Miles Before	100
Daily Miles After	50

Pollutant	Old Emission	New Emission
Total Energy (gasoline gallon equivalent per y	1,173,986.0	117,398.6
Atmospheric CO2 (ton per year)	10,444.7	1,044.5
Nox (ton per year)	12.2	1.2
CO (ton per year)	268.8	26.9

Figure 12: Telework Tool

- In this scenario, a company with 1,000 employees implements a telework policy allowing 200 employees to work from home, reducing their daily commute from 100 miles to 50 miles. This reduction in travel lowers the emissions associated with commuting:

- Total Energy (gasoline gallon equivalent per year) sees a reduction from 1,173,986 units to 117,398.6 units due to fewer commuting miles.
- Atmospheric CO_2 emissions (tons per year) are reduced from 10,444.7 tons to 1,044.5 tons.
- NO_x emissions (tons per year) drop from 12.2 tons to 1.2 tons.
- CO emissions (tons per year) decreased from 268.8 tons to 26.9 tons.

This example illustrates the substantial environmental benefits of teleworking by reducing daily vehicle miles traveled, directly impacting emissions from transportation.

4.3 Transit Bus Upgrades & System Improvements

4.3.1 Functionality

- This calculator provides an estimate of the emissions reduction achieved through retrofitting transit buses. This only applies to diesel buses.

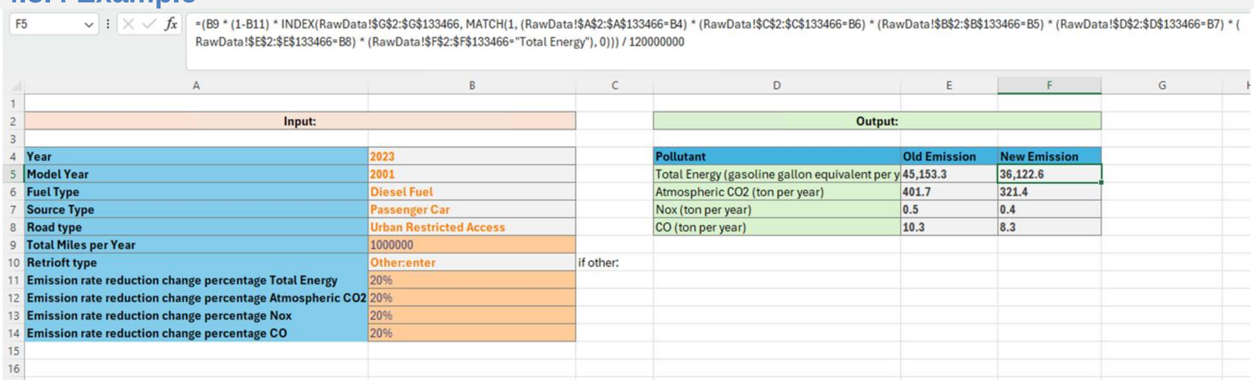
4.3.2 How to Operate

- Input Year, Road type, Old and New Model Years, Fuel Types, and Source Types are used to establish the emission rate. Enter total miles per year, retrofit type, and percentage change in emission rates for Total Energy, Atmospheric CO_2, NO_x, and CO.

4.3.3 Results

- The tab calculates the reduction in emissions achieved by upgrading the bus fleet. It considers the differences in emissions factors between the old and new bus models across various pollutants such as NOx, PM, and CO2.
- Formula: Old Emission = Total Miles per Year * Emission Rate
New Emission = Total Miles per Year * (1 - Emission Rate Reduction Percentage) * Emission Rate

4.3.4 Example



F5 =(B9 * (1-B11) * INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B6) * (RawData!$B$2:$B$133466=B5) * (RawData!$D$2:$D$133466=B7) * (RawData!$E$2:$E$133466=B8) * (RawData!$F$2:$F$133466="Total Energy"), 0))) / 120000000

Input:		
Year	2023	
Model Year	2001	
Fuel Type	Diesel Fuel	
Source Type	Passenger Car	
Road type	Urban Restricted Access	
Total Miles per Year	1000000	
Retrioft type	Other:enter	if other:
Emission rate reduction change percentage Total Energy	20%	
Emission rate reduction change percentage Atmospheric CO2	20%	
Emission rate reduction change percentage Nox	20%	
Emission rate reduction change percentage CO	20%	

Output:		
Pollutant	Old Emission	New Emission
Total Energy (gasoline gallon equivalent per y	45,153.3	36,122.6
Atmospheric CO2 (ton per year)	401.7	321.4
Nox (ton per year)	0.5	0.4
CO (ton per year)	10.3	8.3

Figure 13: Transit Bus Upgrades & System Improvements

- In this scenario, a transit authority decides to retrofit an older fleet of diesel buses to reduce emissions. Assuming the retrofit improves the emission reduction by 20% across all categories for a fleet that covers 1,000,000 miles annually:

- Total Energy (gasoline gallon equivalent per year) decreases from 45,153.3 units to 36,122.6 units.
- Atmospheric CO2 emissions (tons per year) are reduced from 401.7 tons to 321.4 tons.
- NOx emissions (tons per year) drop from 0.5 to 0.4 tons.
- CO emissions (ton per year) decreased from 10.3 tons to 8.3 tons.

This example highlights the effectiveness of retrofitting older buses to meet newer emission standards, demonstrating reductions in key pollutants and improving overall air quality.

4.4 Transit Bus Service and Fleet Expansion

4.4.1 Functionality

- This calculator estimates emission reductions resulting from projects that increase transit bus services and fleet size, such as the introduction of new routes, schedules, or vehicles. The calculated reductions reflect the shift from passenger vehicle use to transit. Users are encouraged to project travel activity by mode using an external travel demand model.

4.4.2 How to Operate

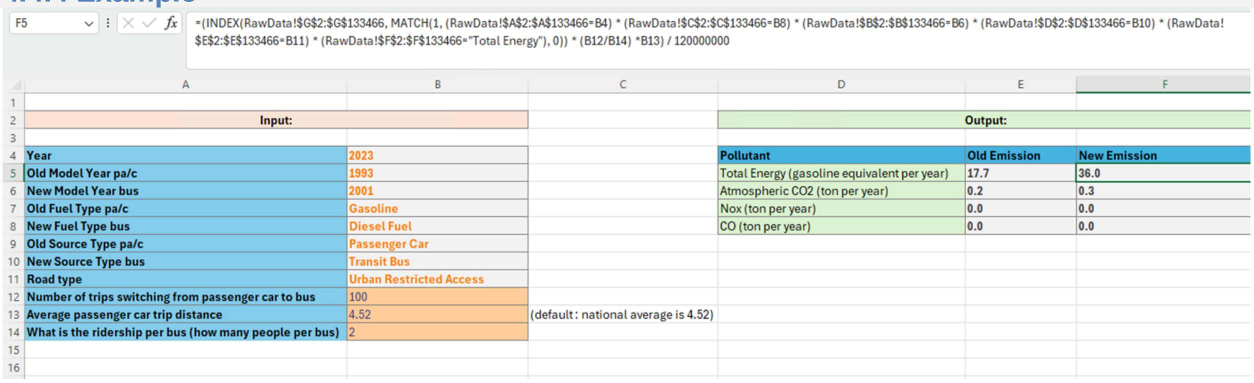
- Input Year, Road type, Old and New Model Years, Fuel Types, and Source Types to determine emission rates. Enter the number of trips switching from cars to buses, average car trip distance, and average ridership per bus.

4.4.3 Results

- Calculates emissions avoided by shifting to public transportation.

- Formula: Old Emission = Number of trips * Average car trip distance * Old Emission Rate
New Emission = (Number of trips / Average ridership per bus) * Average car trip distance * New Emission Rate

4.4.4 Example



F5 =(INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B8) * (RawData!$B$2:$B$133466=B6) * (RawData!$D$2:$D$133466=B10) * (RawData!$E$2:$E$133466=B11) * (RawData!$F$2:$F$133466="Total Energy"), 0)) * (B12/B14) *B13) / 120000000

Input:			Output:		
Year	2023		Pollutant	Old Emission	New Emission
Old Model Year pa/c	1993		Total Energy (gasoline equivalent per year)	17.7	36.0
New Model Year bus	2001		Atmospheric CO2 (ton per year)	0.2	0.3
Old Fuel Type pa/c	Gasoline		Nox (ton per year)	0.0	0.0
New Fuel Type bus	Diesel Fuel		CO (ton per year)	0.0	0.0
Old Source Type pa/c	Passenger Car				
New Source Type bus	Transit Bus				
Road type	Urban Restricted Access				
Number of trips switching from passenger car to bus	100				
Average passenger car trip distance	4.52	(default: national average is 4.52)			
What is the ridership per bus (how many people per bus)	2				

Figure 14: Transit Bus Service and Fleet Expansion

- In this setup, a city enhances its transit bus service by introducing newer, cleaner buses and increasing service routes, resulting in a mode shift from cars to buses. Assume 100 trips are converted daily, with an average passenger car trip distance of 4.52 miles and a bus carrying two passengers per trip.

- Total Energy (gasoline gallon equivalent per year): The transition increases from 17.7 to 36.0 gasoline gallon equivalents per year due to increased bus activity, reflecting the added energy consumption by the buses.
- Atmospheric CO2 emissions (ton per year): The CO2 emissions increase from 0.2 tons to 0.3 tons per year, indicating a shift in emissions from passenger vehicles to buses.
- NOx and CO emissions (ton per year): NOx and CO emissions show no change, remaining at 0.0 tons per year, likely due to the newer buses' stringent emission controls.

This example illustrates the changes in urban transportation dynamics, emphasizing improved public transit accessibility and its impact on reducing reliance on passenger cars while highlighting potential trade-offs in emissions when increasing bus usage.

4.5 Electric Vehicles and EV Charging Infrastructure

4.5.1 Functionality

- This calculator estimates emissions reductions achieved by replacing a conventional fuel vehicle fleet with electric vehicles and/or by altering mileage due to the adoption of new restricted access charging infrastructure, if applicable. It does not account for lifecycle emissions, especially those beyond vehicle operations. For electric transit buses and their charging infrastructure, please refer to the Transit Bus Upgrades & System Improvements tool.

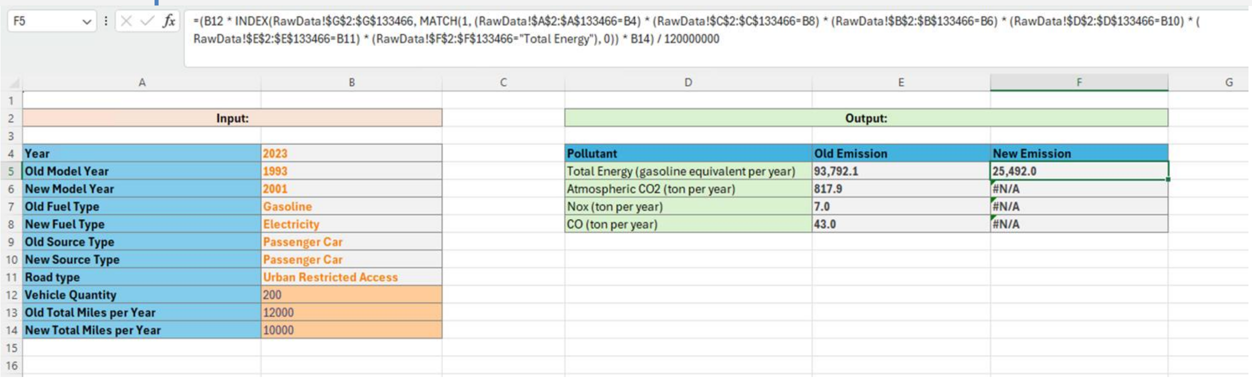
4.5.2 How to Operate

- Input Year, Road type, Old and New Model Years, Fuel Types, and Source Types are used to establish emission rates. Enter the number of vehicles and the total miles per year for old and new vehicles.

4.5.3 Results

- The tab calculates the expected decrease in emissions due to a higher adoption rate of electric vehicles facilitated by the new infrastructure. This includes direct reductions in tailpipe emissions and potential shifts in emissions related to electricity generation, depending on the energy mix powering the charging stations.
- Formula: Old Emission = Vehicle Quantity * Old Total Miles per Year * Old Emission Rate
New Emission = Vehicle Quantity * New Total Miles per Year * New Emission Rate

4.5.4 Example


F5 =(B12 * INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B8) * (RawData!$B$2:$B$133466=B6) * (RawData!$D$2:$D$133466=B10) * (RawData!$E$2:$E$133466=B11) * (RawData!$F$2:$F$133466="Total Energy"), 0)) * B14) / 120000000

Input:	
Year	2023
Old Model Year	1993
New Model Year	2001
Old Fuel Type	Gasoline
New Fuel Type	Electricity
Old Source Type	Passenger Car
New Source Type	Passenger Car
Road type	Urban Restricted Access
Vehicle Quantity	200
Old Total Miles per Year	12000
New Total Miles per Year	10000

Output:		
Pollutant	Old Emission	New Emission
Total Energy (gasoline equivalent per year)	93,792.1	25,492.0
Atmospheric CO2 (ton per year)	817.9	#N/A
Nox (ton per year)	7.0	#N/A
CO (ton per year)	43.0	#N/A

Figure 15: Electric Vehicles and EV Charging Infrastructure

- In this scenario, a city will replace 200 gasoline passenger cars with electric vehicles to enhance its urban restricted access infrastructure. This replacement occurs over miles traveled annually, from 120,000 miles for gasoline cars to 100,000 miles for electric vehicles.

- Total Energy (gasoline gallon equivalent per year): The shift from gasoline to electricity for these vehicles reduces the total energy consumption from approximately 93,792.1 gasoline gallon equivalents per year to 25,492.0, reflecting the higher efficiency of electric vehicles.
- Atmospheric CO_2 emissions (ton per year): CO_2 emissions are reduced from 817.9 tons to #N/A because the new emission rate for CO_2 is not applicable or cannot be calculated.
- NO_x and CO emissions (ton per year): Since electric vehicles do not emit NO_x and CO through tailpipes, these emissions are not applicable, hence the #N/A in the table.

This example underscores the environmental benefits of transitioning to electric vehicles, particularly in reducing greenhouse gases and air pollutants, alongside adapting urban infrastructure to support such a shift.

4.6 Carpooling and Vanpooling

4.6.1 Functionality

- This calculator estimates the reduction in emissions achieved through carpooling.

4.6.2 How to Operate

- Input Year, Model Year, Fuel Type, Source Type, and Road type to determine the emission rate. Enter the number of people participating in the carpooling program, the average number of passengers per vehicle, and the average commute distance.

4.6.3 Results

- Shows a decrease in emissions by reducing the number of vehicles on the road.

- Formula: Old Emission = Number of people * Average commute distance * Emission Rate
New Emission = (Number of people / Average passengers per vehicle) * Average commute distance * Emission Rate

4.6.4 Example

F5 =(INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B6) * (RawData!$B$2:$B$133466=B5) * (RawData!$D$2:$D$133466=B7) * (RawData!$E$2:$E$133466=B8) * (RawData!$F$2:$F$133466="Total Energy"), 0)) * (B9/B10) * B11) / 120000000

Input:	
Year	2023
Model Year	1993
Fuel Type	Diesel Fuel
Source Type	Passenger Car
Road type	Urban Restricted Access
Number of People participate in your carpooling program	30000
On average, how many passengers are there per carpool vehicle?	3
What is the average commute distance?	20

Output:		
Pollutant	Old Emission	New Emission
Total Energy (gasoline gallon equivalent per year)	26,860.2	8,953.4
Atmospheric CO2 (ton per year)	239.0	79.7
Nox (ton per year)	2.0	0.7
CO (ton per year)	11.9	4.0

Figure 16: Carpooling and Vanpooling

- In this scenario, a company implements a carpooling program encouraging 30,000 participants to share rides. Assuming each carpool consists of 3 passengers sharing a ride, and employees originally commute 20 miles individually, the program reduces the total number of trips.

- Old Emission: Before the carpooling initiative, the total mileage would be calculated as 30,000 participants × 20 miles = 600,000 miles.
- New Emission: With carpooling, the number of trips is reduced. Now, only 10,000 vehicles are needed for the same number of people (30,000 / 3), resulting in 10,000 vehicles × 20 miles = 200,000 miles.

The emission reduction can be calculated based on the difference in miles traveled before and after the implementation of the carpooling program, illustrating a reduction in travel by 400,000 miles. This reduction directly translates into a decrease in emissions:

- Total Energy (gasoline gallon equivalent per year): Reduced from 26,860.2 to 8,953.4.
- Atmospheric CO2 emissions (ton per year): Reduced from 239.0 to 79.7.
- NOx emissions (ton per year): Reduced from 2.0 to 0.7.
- CO emissions (ton per year): Reduced from 11.9 to 4.0.

This example highlights the substantial environmental benefits of carpooling, which directly reduces the number of vehicles on the road, thereby decreasing emissions, improving air quality, and reducing traffic congestion.

4.7 Bicycle, Pedestrian, and Shared Micromobility

4.7.1 Functionality

- This calculator will estimate the reduction in emissions resulting from improvements to bicycle and pedestrian infrastructure and associated mode shift from passenger vehicles to bicycling or walking, including but not limited to sidewalks, dedicated bicycle infrastructure, improved wayfinding, mid-block crossing installations, bike share systems, and bike parking improvements.

4.7.2 How to Operate

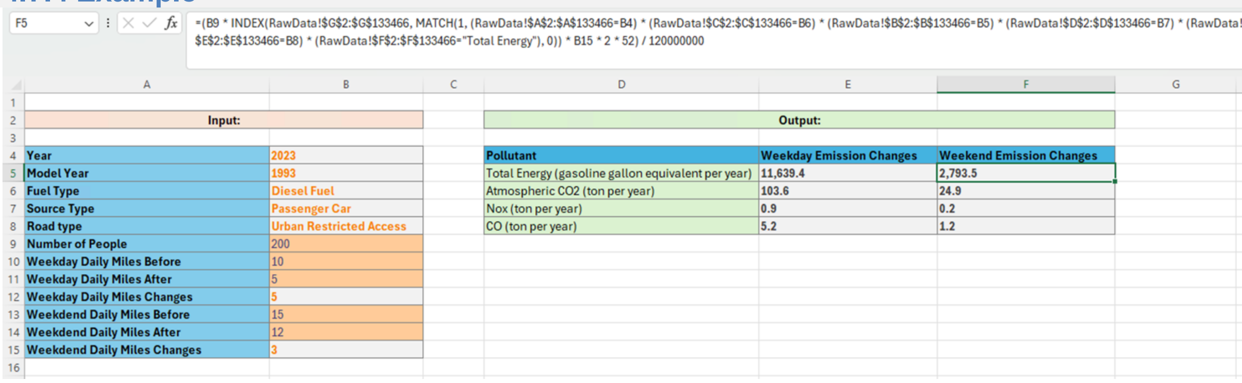
- Input year, model year, fuel type, source type, and road type are used to establish the emission rate. Input the number of people, weekday and weekend daily miles before and after, automatically generating daily miles changes.

4.7.3 Results

- Estimates the amount of emissions reduced due to increased cycling.
- Formula: Weekday Emission Changes = Number of People * Weekday Daily Miles Changes * 5 * 52 * Emission Rate

Weekend Emission Changes = Number of People * Weekend Daily Miles Changes * 2 * 52 * Emission Rate

4.7.4 Example



F5 =(B9 * INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B6) * (RawData!$B$2:$B$133466=B5) * (RawData!$D$2:$D$133466=B7) * (RawData!$E$2:$E$133466=B8) * (RawData!$F$2:$F$133466="Total Energy"), 0)) * B15 * 2 * 52) / 120000000

Input:	
Year	2023
Model Year	1993
Fuel Type	Diesel Fuel
Source Type	Passenger Car
Road type	Urban Restricted Access
Number of People	200
Weekday Daily Miles Before	10
Weekday Daily Miles After	5
Weekday Daily Miles Changes	5
Weekend Daily Miles Before	15
Weekend Daily Miles After	12
Weekend Daily Miles Changes	3

Pollutant	Weekday Emission Changes	Weekend Emission Changes
Total Energy (gasoline gallon equivalent per year)	11,639.4	2,793.5
Atmospheric CO2 (ton per year)	103.6	24.9
Nox (ton per year)	0.9	0.2
CO (ton per year)	5.2	1.2

Figure 17: Bicycle, Pedestrian, and Shared Micromobility

- In this scenario, a city implements a bike-sharing program involving 200 residents to promote biking and walking. Originally, these residents each drove 11 miles to work on weekdays and 15 miles for weekend outings. With the introduction of the bike-sharing program, their daily miles on weekdays were reduced to 5 miles by car, and on weekends, they were reduced to 12 miles.

- Weekday Emission Changes: The total weekday emissions were originally calculated as 200 people × 11 miles = 2,200 car miles daily. After the program, car miles were reduced to 200 people × 5 miles = 1,000 car miles daily.

The reduction in mileage directly translates into a reduction in emissions:

- Total Energy (gasoline gallon equivalent per year): Reduced by 11,639.4.
- Atmospheric CO2 emissions (ton per year): Reduced by 103.6.
- NOx emissions (ton per year): Reduced by 0.9 tons.
- CO emissions (ton per year): Reduced by 5.2 tons.

- Weekend Emission Changes: On weekends, originally 200 people × 15 miles = 3,000 car miles daily. After the program, car miles were reduced to 200 people × 12 miles = 2,400 car miles daily.

The reduction in mileage directly translates into a reduction in emissions:

- Total Energy (gasoline gallon equivalent per year): Reduced by 2,793.5.
- Atmospheric CO2 emissions (ton per year): Reduced by 24.9.
- NOx emissions (ton per year): Reduced by 0.2.

- CO emissions (ton per year): Reduced by 1.2.

The reduction in car mileage resulted in significant emission decreases, with weekday reductions of 11,639.4 gallons of fuel and 103.6 tons of CO_2, and weekend reductions of 2,793.5 gallons of fuel and 24.9 tons of CO_2. These results highlight the substantial environmental benefits of the bike-sharing program, contributing to lower fuel consumption, reduced emissions, and improved air quality.

4.8 Alternative Fuel Vehicles and Infrastructure

4.8.1 Functionality

- This calculator will estimate the reduction in emissions when purchasing alternative fuel vehicles to replace a conventional fuel vehicle fleet and/or the change in mileage to new restricted access alternative fuel infrastructure, if applicable. Alternative fuel transit buses and transit bus refueling infrastructure are included in the Transit Bus Upgrades & System Improvements tool.

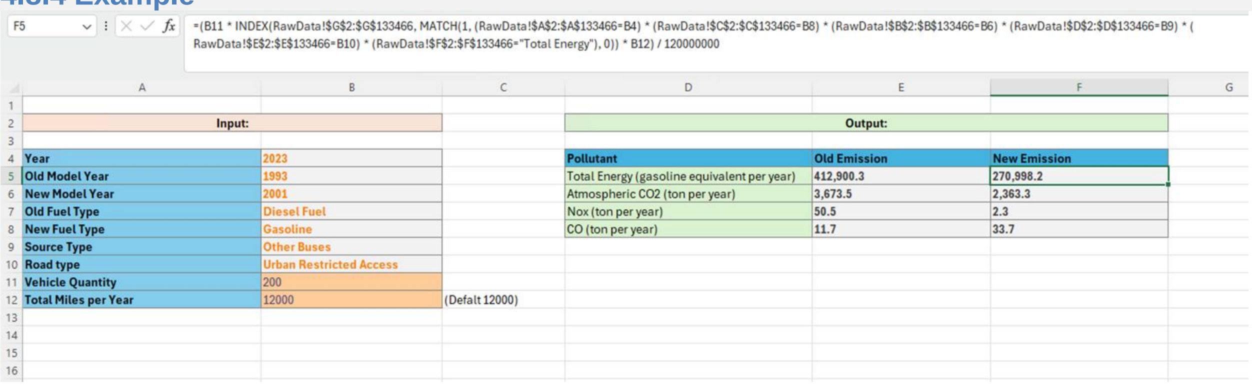
4.8.2 How to Operate

- Input Year, Source Type, Road type, Old and New Model Years, and Fuel Types to determine emission rates. Enter vehicle quantity and total miles per year.

4.8.3 Results

- The tab calculates the expected reduction in emissions by comparing the emissions factors of conventional and alternative fuels.
- Formula: Old Emission = Vehicle Quantity * Total Miles per Year * Old Emission Rate
New Emission = Vehicle Quantity * Total Miles per Year * New Emission Rate

4.8.4 Example



```
F5  =(B11 * INDEX(RawData!$G$2:$G$133466, MATCH(1, (RawData!$A$2:$A$133466=B4) * (RawData!$C$2:$C$133466=B8) * (RawData!$B$2:$B$133466=B6) * (RawData!$D$2:$D$133466=B9) * (RawData!$E$2:$E$133466=B10) * (RawData!$F$2:$F$133466="Total Energy"), 0)) * B12) / 120000000
```

Input:			Output:		
Year	2023		Pollutant	Old Emission	New Emission
Old Model Year	1993		Total Energy (gasoline equivalent per year)	412,900.3	270,998.2
New Model Year	2001		Atmospheric CO2 (ton per year)	3,673.5	2,363.3
Old Fuel Type	Diesel Fuel		Nox (ton per year)	50.5	2.3
New Fuel Type	Gasoline		CO (ton per year)	11.7	33.7
Source Type	Other Buses				
Road type	Urban Restricted Access				
Vehicle Quantity	200				
Total Miles per Year	12000	(Defalt 12000)			

Figure 18: Alternative Fuel Vehicles and Infrastructure

- A city replaces 200 diesel buses with gasoline buses. These buses collectively emit 412,900.3 units of Total Energy (gasoline equivalent per year), 3,673.5 tons of Atmospheric CO_2 per year, and 50.5 tons of NOx per year. Each bus averages 12,000 miles annually.

After the replacement:

- Total Energy emissions reduce to 270,998.2 units per year.
- Atmospheric CO_2 decreases to 2,363.3 tons per year.
- NOx emissions drop to 2.3 tons per year.

- CO emissions increase to 33.7 tons per year from 11.7 tons, indicating a change in emission characteristics due to the new fuel type.

This transition demonstrates the impact of shifting from diesel to gasoline, resulting in considerable reductions in most pollutants, although with an increase in CO emissions due to the specific emission profile of gasoline engines compared to diesel.

CHAPTER 5

Conclusions

In conclusion, this report has delved into the crucial role of transportation in influencing air quality, highlighting the impact of vehicular emissions on environmental degradation and public health. By examining existing tools and models, particularly the MOVES model, we have seen the complexity of accurately quantifying and managing transportation emissions. These tools are vital for policymakers and agencies in planning effective strategies to mitigate the negative impacts of transportation on air quality.

The analysis within this report underscores the importance of having reliable, accessible, and up-to-date tools for air quality assessment. While the MOVES model and other similar tools provide robust platforms for emission calculations, there remains a clear need for improvements in user-friendliness and data relevance, which are crucial for ensuring these tools' practical utility in policy-making and environmental planning.

Furthermore, Congestion Mitigation and Air Quality Improvement (CMAQ) programs exemplify the federal commitment to addressing transportation-related air quality issues. However, the effectiveness of such initiatives heavily relies on the precision of the emission estimates provided by the available models and the consistency of their application across different projects and regions.

To address these challenges, this report has proposed the development of an Excel-based tool designed to bridge the gaps identified in current modeling practices. This tool incorporates updated methodologies and data about contemporary transportation trends and vehicle technologies. By doing so, it promises to enhance the capability of local and state agencies to conduct more precise and comprehensive air quality assessments, thereby facilitating more informed decision-making.

Ultimately, advancing our tools and methods for air quality assessment will support better regulatory compliance and environmental protection and contribute to the broader goal of sustainable development. Improving our ability to forecast and mitigate transportation impacts on air quality can better safeguard public health and ensure a cleaner, more sustainable environment for future generations.

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