Texas A&M Transportation Institute

Subtask 2.1 TWG Technical Issues Analysis: Emissions, Air Quality and Health in Transportation Planning

DRAFT MEMORANDUM

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Texas A&M Transportation Institute

TECHNICAL MEMORANDUM – DRAFT FOR REVIEW

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Sub-Task 2.1 **TWG Technical Issues Analysis: Emissions, Air Quality and Health in Transportation Planning**

DATE: May 19, 2022

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INTRODUCTION

The link between transportation and health continues to receive substantial attention from transportation stakeholders such as the US Department of Transportation (USDOT), state departments of transportation, and other regional and local transportation planning organizations. At the federal level, the USDOT and Federal Highway Administration (FHWA) have focused on advancing a transportation and health planning framework and have made a wide range of resources available to help practitioners and decision makers improve public health. From an emissions and air quality perspective, practitioners seek to understand how and to what extent vehicle tailpipe emissions affect measured air quality, and in turn, the impact of those emissions on public health. As seen in air quality and traffic trends during the COVID-19 pandemic, large reductions in traffic volumes did not necessarily improve air quality as measured by monitoring networks. Beyond air quality and health linkages, the transportation planning process also affects health through multiple interrelated pathways, such as safety, access, and noise.

As the transportation sector continues to improve how to address health, including emissions-related health issues in the transportation planning process, several transportation agencies, such as state Department of Transportations (DOTs), metropolitan planning organizations (MPOs), and councils of government (COGS). have undertaken initiatives in this area. In Texas, large highway projects have raised concerns about transportation and public health, and the public, transportation agencies, and other relevant stakeholders are keen to understand how health impacts can be assessed and mitigated.

This memorandum will provide the Texas Department of Transportation (TxDOT) and the Technical Working Group for Mobile Source Emissions (TWG) with an overview of up-to-date best practices and tools for addressing air quality and health issues. It also presents a case study conducted by Texas A&M Transportation Institute (TTI) to document how air quality and health evaluations can be applied in urban areas within Texas. For this case study, TTI staff evaluated the urban area of Austin, Texas.

BEST PRACTICES AND TOOLS FOR ADDRESSING AIR QUALITY AND HEALTH ISSUES RELATED TO TRANSPORTATION

The following subsections provide an update on best practices and the latest available tools for addressing air quality and health-related issues in transportation planning, looking specifically at the areas of air-quality improvement; safety; social equity and access; active transportation; and context sensitive solutions. In addition, an overview of the state of the practice for incorporating health into transportation planning at the federal and state level area is also provided.

Transportation and Public Health Impacts

Transportation systems help mold the design, operation, and connectivity of communities, but can also have significant impacts on public health. Linking health and transportation allows transportation planners and health professionals to collaborate and improve transportation decisions and processes. The USDOT identifies six main objectives to address public health in transportation (*1*). The objectives, which are summarized in

Table **1**, collectively affect health and health outcomes and should play an important role in transportation decision making.

Table 1. USDOT Objectives for Health and Transportation

OBJECTIVES	DESCRIPTION
IMPROVE AIR QUALITY	Transportation planning and decisions that reduce vehicle emissions improves air quality for everyone. Children, older adults, and individuals with respiratory diseases benefit the most.
PROMOTE SAFETY	Effective safety countermeasures and promoting safe behavior among all road users can reduce the number of fatalities and injuries, especially for pedestrians and bicyclists.
IMPROVE SOCIAL EQUITY AND ACCESS	Affordable and convenient transportation options can promote more equitable opportunities between and within communities. They can also improve access to desired locations.
CREATE ADDITIONAL OPPORTUNITIES FOR ACTIVE TRANSPORTATION AND RIDE/VEHICLE SHARING	Increased and improved bicycle and pedestrian (active transportation and recreation) infrastructure promotes physical activity. Physical activity can help improve health outcomes for individuals.
RESPECT THE NATURAL ENVIRONMENT THROUGH CONTEXT SENSITIVE SOLUTIONS (CSS)	The CSS process is a collaborative and holistic approach to the development of transportation projects. It involves local communities and preserves environmental, cultural, aesthetic, and other resources values of the area, while improving or maintaining safety, mobility, and infrastructure conditions.

CONDUCT RESEARCH ON TRANSPORTATION'S ROLE IN IMPROVING QUALITY OF LIFE	Research done on transportation's role in improving quality of life for the public can help improve processes and policies that support the objectives above. This report also contributes to this objective.

The following subsections will use the USDOT's comprehensive objectives to expand upon current considerations of health in transportation planning by providing an overview of the state of the practice for how each public health objective is incorporated into the transportation planning and programing process. In addition, current trends and the evaluation tools that assist practitioners and decision makers improve public health outcomes through the transportation planning process are included. A summary of the latest tools is also provided in **Table 2** below.

Table 2. Resources and Tools for the Consideration of Health in Transportation

ITEM	DESCRIPTION
MOTOR VEHICLE EMISSIONS SIMULATOR (MOVES)	The US Environmental Protection Agency's (US EPA) MOVES tool is an emissions modeling system that estimates emissions for mobile sources at several geographic levels for criteria air pollutants, greenhouse gases, and air toxics.
TRANSPORTATION CLIMATE CHANGE SENSITIVITY MATRIX	The US Climate Resilience Toolkit provides information on the sensitivity of six transportation modes and sub-modes to 11 potential climate impacts.
TRANSPORTATION ASSESSMENT TOOLKIT	OpenEI produce the Transportation Assessment Toolkit to help governments at all levels plan the development of economically and environmentally sustainable transport systems that support development.

HEALTH ECONOMIC ASSESSMENT TOOL (HEAT)	The World Health Organization (WHO) Europe developed the HEAT tool to allow users without experience in impact assessment to conduct economic assessments of the health impacts of walking or cycling.
PREDICTING PERFORMANCE WITH TRAFFIC ANALYSIS TOOLS	The FHWA provides resources and information on how well simulation and traffic analysis tools predict performance and identifies elements and issues that transportation practitioners should be aware of to effectively apply these tools.
TRANSPORTATION AND HEALTH TOOL	The USDOT and Center for Disease Control and Prevention (CDC) developed the Transportation and Health Tool to provide accessible data that practitioners can use to analyze the health impacts of transportation systems.
TOOLKIT FOR BUS STOP SAFETY	The National Aging and Disability Transportation Center provides this toolkit for staffs at transportation agencies and public works departments who are responsible for bus stop design and placement. The toolkit can be used to enhance the accessibility of stops or help develop a strategic plan to system-wide accessibility.
SAFEFITS – A ROAD SAFETY DECIONS-MAKING TOOL	The SafeFITS tool, developed by the United Nations Economic Commission for Europe (UNECE), allows users to analyze, forecast, and benchmark road safety measures, outcomes, and scenarios.

Improving Air Quality

Motor vehicles are responsible for approximately half of volatile organic compounds (VOC), more than half of oxides of nitrogen (NOx) emissions, and three quarters of carbon monoxide (CO) emissions in the United States. Vehicle emissions from transportation systems impact health through human exposure to toxins contained within these emissions (*2*). All vehicular emissions are considered toxic to human health and are linked to adverse human health impacts. Texas has seen improvements in air quality, as annual measurements of PM 2.5 have reduced throughout the state (*3)*(*4*). However, air quality remains a significant public health issue for transportation planning agencies, especially due to increased travel demand in the wake of the COVID-19 pandemic. As transportation agencies in Texas grapple with the issue of reducing vehicular emissions and improving air quality for communities, publicly available reports, tools, and databases, such as the previously mentioned CDC National Environmental Public Health Tracking Tool, provide information about health impacts and the cost of air pollution in Texas and the United States. Figure 1 displays the general decrease in PM2.5 levels in Texas counties from 2006 to 2016. The legends included within the figure display the varying intensities of PM2.5 levels and how they have changed over a ten-year timespan. While PM2.5 levels in Texas generally show improvement over time, urban metropolitan areas still have room to improve air quality, and in turn, promote better health outcomes for local communities and individuals.

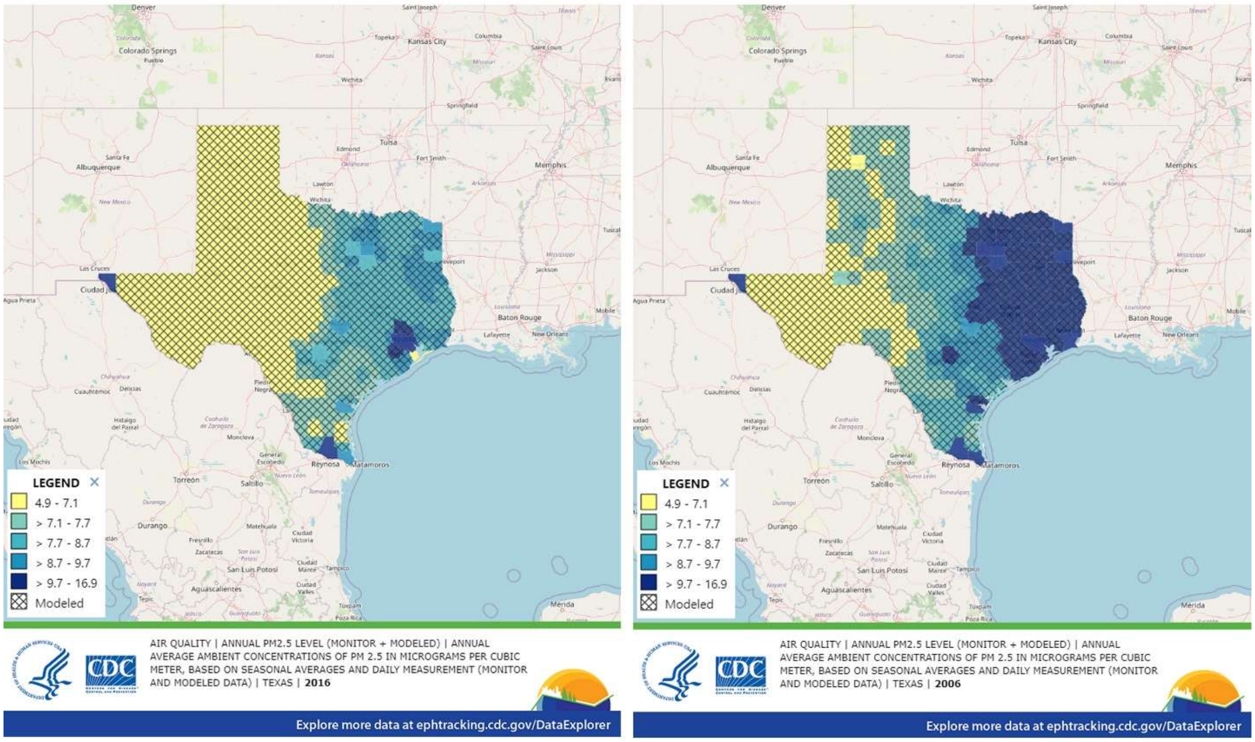

Figure 1: 2016 vs 2006 Air Quality | Annual PM2.5 Levels (Monitored and Modeled) for Texas counties

PM2.5 is closely associated with transportation related air pollution (TRAP), as it is estimated that vehicle emissions are responsible for nearly 20% of all ambient PM2.5 and Ozone related mortality in the United States (*5*). While PM2.5 levels are a significant indicator of TRAP, there are other contributing factors. TRAP has been shown to adversely impact human health, such as premature death, lung cancer, cardiovascular, and cardiopulmonary diseases (*6*). Using the CDC National Environmental Public Health Tracking Tool, an analysis of the available 2014 data showed that a total of 958 Texans would have avoided death from coronary heart disease if there had been a 10% reduction of PM2.5 emissions (*7*).

As discussed in *Potential Framework for Integrating Air Quality and Health Considerations in Texas' Transportation Planning* (2016), transportation air quality issues related to human health impacts are addressed through the framework of transportation conformity requirements per the National Ambient Air Quality Standards (NAAQS) for areas of nonattainment (*8*). Such analyses are part of TxDOT's project development process rather than the transportation planning process. However, they are still of interest to TxDOT as they affect conformity. In addition, TxDOT receives funding from the Congestion Mitigation and Air Quality Improvement program, which are tied to non-attainment and may be spent on projects or programs that reduce congestion and help a metropolitan area meet or continue meeting relevant national air quality standards (*9*). Essentially, transportation conformity ensures that network-level transportation emissions (at the transportation plan level) in a region are kept below a certain threshold. Additionally, project-level conformity requirements (in the form of "hot-spot" analyses or other requirements) need to be met in some cases to ensure that there are no localized incidences of high exposure levels. While such analyses are part of the project development process rather than the planning process, they are of interest to TxDOT and do affect conformity.

Safety

In 2017, over 6.4 million police-reported traffic crashes occurred in the United States, killing over 34,000 and injuring over 1.8 million (*10*). The early projection of motor vehicle fatalities by the National Highway Transportation Safety Administration (NHTSA) estimates that 38,680 people died in motor vehicle traffic crashes in 2020 (*11*). This is significant because it shows that motor vehicle fatalities on roadways in the United States have increased every year since 2017. Safety remains a significant health impact factor for transportation and transportation planning. TxDOT promotes safety on the Texas transportation system through several initiatives, including Road to Zero Deaths, their Pedestrian Safety Campaign, and their #EndTheStreakTX roadway safety social media campaign (*12*). TxDOT is committed to reducing the streak of traffic deaths in Texas through public safety education campaigns and investments to improve transportation, safety relevant infrastructure, and increased enforcement of traffic laws (*13*). TxDOT allocated an additional $600 million for FY 2020-2021 for the Road to Zero goal of zero fatalities on Texas roadways by 2050. Ninety safety projects were funded in FY 2020 (*14*). According to the TxDOT 2050 Texas Transportation Plan (TTP), an average of 10 deaths and 48 serious injuries are reported every day on Texas public roadways (*9*)(*16*). Table **3** displays traffic fatalities and injuries per year from 2017 to 2020 in Texas.

Table 3. Texas Roadway Fatalities and Injuries by Year since 2017

Year	Fatalities	Injuries
2017	34,247	2,740,000
2018	36,835	2,710,000
2019	36,096	2,745,000
2020*	38,680*	-*

It is important to note that roadway safety in Texas continues to be a significant issue, particularly during and in the wake of the COVID-19 pandemic. Despite drops in travel demand, traffic fatalities still increased in 2020. As TxDOT continues to promote and emphasize safety related infrastructure and safe driving behavior, roadway safety remains an important nexus of health and transportation in Texas.

TxDOT has six different emphasis areas pertaining to safety and fatality prevention and reduction. The six emphasis areas include (*13*):

- Involving Run off the Road
- Involving DUI
- Involving Intersections
- Involving Distracted Driving
- Pedestrians
- Pedalcyclists

According to the TxDOT Performance Dashboard, safety of drivers on Texas roadways is TxDOT's top priority. It strives to continually improve guidelines, awareness, and education to reduce crashes and deaths. Figure 2 displays fatalities by emphasis area by year. Tracking these safety related emphasis areas allows them to measure the effectiveness of the actions and initiatives that are taken. Improving safety on Texas roadways is a major initiative that TxDOT is undertaking through improvements in infrastructure, educational materials, and greater public engagement.

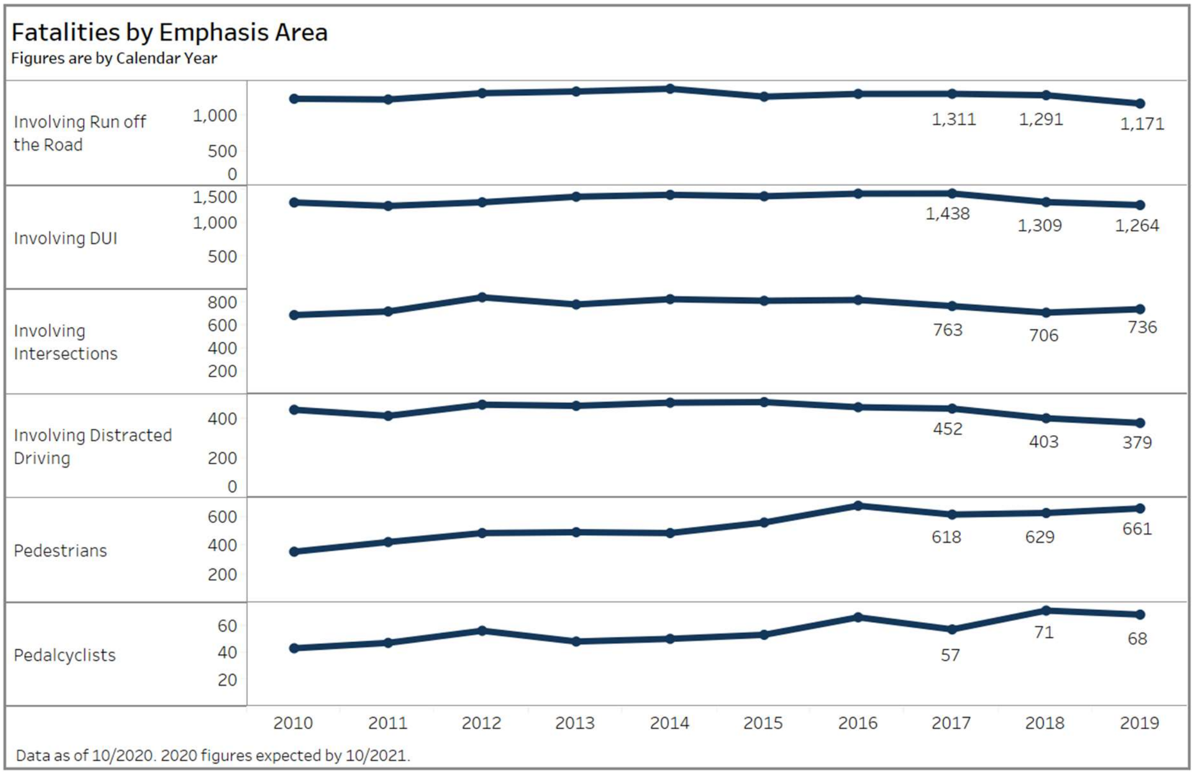

Figure 2. Texas Roadway Fatalities by Emphasis Area from 2010 to 2019

Improving Social Equity and Access to Destinations

Air quality and safety are well established responsibilities of transportation agencies and departments, and access to healthy destinations and active transportation are increasingly viewed as relevant to public health and transportation. Healthy access to desired destinations provides activities and equitable opportunities to all population groups. TxDOT has incorporated goals and objectives into the most recent 2050 TTP through improvements in current transportation infrastructure, as well as non-highway and multi-modal strategies. However, these components of health and transportation should be considered and implemented more explicitly through greater consideration of access to desired and healthy destinations and active transportation options. Access to desired locations—such as goods, services, and opportunities—supports USDOT's social equity and access objective and relates to multi-modal and active transportation.

Desired access types include:

- Access to health care and social services
- Access to employment opportunities
- Pedestrian/Cycling access to daily goods and services
- Choice of transportation mode (i.e., public transit, personal vehicle, bike, etc.)
- Local transportation design criteria:
    - Universal design (Context sensitive and complete streets)
    - Multimodal
    - Transit-oriented development

Access is one of the links between transportation and health that the Center for Advancing Research in Transportation Emissions, Energy, and Health (CARTEEH) Fourteen Pathways to Health report identifies (*5*). In a transportation context, access is the ability for individuals to reach employment, education, health services, public transportation, social networks, recreation and leisure, and other services. Access to healthy destinations in the context of transportation and health provides individuals with desired types of access and can promote active transportation through more pedestrian friendly street and transit design.

Access to healthcare destinations and facilities is crucial for vulnerable populations. Initiatives to improve healthcare access through improvements in public transit and multimodal transportation connections can promote and improve public health. *The Guidebook for Communities to Improve Access to Health* (TCRP Report No. 223) examines the connection between health care and transportation and provides possible solutions and frameworks that transportation agencies can utilize to promote and improve health care access and connections. Transportation is often cited as a barrier to health care access, and the availability of transportation influences the ability of individuals to access health care. Through the Accountable Health Communities Model (a Centers for Medicare and Medicaid Services (CMS) initiative), the federal government is encouraging and promoting collaboration between health-care providers and community services, including transportation, to provide responsive and available service that fulfills the needs of communities (*17*). Resources, such as this guidebook, are available for transportation agencies to utilize to improve transportation access to health services and other needs. These resources and initiatives serve as guidance for TxDOT and other transportation agencies on how to consider and incorporate health care access into transportation systems, as well as collaborate with health care organizations and agencies. If TxDOT decides to pursue health related initiatives in its transportation planning, these resources and frameworks can provide necessary information and support.

Active Transportation

Active transportation promotes fitness and activity for individuals. This can help reduce certain health risks, such as cardiovascular disease and some types of cancers (*18*). Physical activity can be impacted and influenced by the built environment (i.e., bike lanes and sidewalks) (*19*)(*20*). Throughout the United States, transportation planners and policy makers have been promoting and implementing active transportation through improvements in infrastructure that facilitate active transportation modes. The TxDOT 2050 TTP addresses active transportation through integration of bicycle and pedestrian needs into planning processes. Active transportation can be achieved through a variety of characteristics, which are summarized in

Table **4**.

Table 4. Characteristics of Effective Active Transportation

ITEM	DESCRIPTION
INFRASTRUCTURE	Make appealing to pedestrians and bicyclists Encourage decisions that support walking, biking, non-motorized forms of travel
NON-MOTORIZED TRIP OPPORTUNITIES	Complete streets (shorter trips) Partial walk and bicycle links (multi-modal trips) Coordination of transportation and recreational infrastructure
CHOICE OF MODES	Encouraging physical activity and fitness Car/Ride and bicycle share programs Public transportation options (buses, rail)
LAND USE/TRANSPORTATION DESIGN	Land use mix (i.e., Mixed use development) Compactness/Density of development Connectivity and linkage - Affordable housing and transportation - Interactive and complementary land uses

Investing in active transportation infrastructure has been estimated to improve active travel rates by individuals, and that modal diversity is inversely associated with obesity and physical inactivity (*5*). Improvements and promotion of active transportation infrastructure in Texas by TxDOT can improve public health outcomes through greater physical activity and fewer vehicle miles traveled. In addition, with the new federal focus on transportation infrastructure in the United States, we expect that active transportation infrastructure and initiatives will be a key component in addressing health and transportation issues.

Context Sensitive Solutions

CSS is a collaborative, interdisciplinary, and holistic approach to the development and implementation of transportation projects and initiatives (*21*). TxDOT utilizes this approach to consider environmental issues and involve all stakeholders, including community members, elected officials, interest groups, and relevant local, state, and federal agencies.

TxDOT's CSS fact sheet includes four guiding principles:

- Strive towards a shared stakeholder vision to provide a basis for decisions.
- Demonstrate a comprehensive understanding of contexts.
- Foster continuing communication and collaboration to achieve consensus.
- Exercise flexibility and creativity to shape effective transportation solutions, while preserving and enhancing community and natural environments.

The CSS process emphasizes public engagement, communication, and mutually supportive and coordinated decision making in transportation projects and plans. Utilizing a CSS process can aid in preserving and promoting community and natural environment surrounding a project. In addition, the FHWA provides case studies and resources on implementing the CSS process (*22*). The CSS process is an important component in incorporating health into transportation planning and provides an avenue for TxDOT to preserve and enhance environmental impacts of projects and support community involvement in transportation planning.

Incorporating Health into Transportation Planning Practice

Federal and state policies regarding health and transportation impact how transportation planning agencies and organizations plan and implement projects and programs that impact public health. Federal regulatory and programming framework for transportation funding allocation and planning requirements have generally been consistent over the past 25 years. The framework provides opportunities and flexibility for TxDOT and MPOs across Texas to address health issues in transportation. In addition, recent infrastructure focused proposals at the federal level provide greater context and guidance for transportation planners and policy makers.

Federal Context

There are several federal regulations and policies that promote health in transportation planning practices. Traditionally, emissions related to health issues have been addressed through the regulatory process tied to conformity, and in some nonattainment areas through project-level conformity requirements. The National Environmental Policy Act also required local air quality analysis in some cases (*8*).

The USDOT considers the importance of promoting better consideration of health outcomes, and focuses on objectives of safety, air quality, protection of natural environment, social equity, physical activity, active transportation options, and quality of life. The general USDOT policies support safe, accessible, and healthy communities.

Now, there are more integrated approaches to planning for public health, including air quality, that go beyond regulatory requirements. The FHWA developed a framework for the consideration of health in transportation corridor planning and provides guidance and resources for transportation agencies and MPOs.

Table 5 provides a summary of how several federal initiatives, resources, and policies relate to how transportation affects health and health outcomes.

Table 5. Health Aspects of Transportation Programs, Initiatives, and Policies

ITEM	DESCRIPTION
NAAQS	Transportation air quality issues (that are intended to protect human health) are addressed through the framework of transportation conformity requirements in air quality non-attainment areas.
FWHA BICYCLE AND PEDESTRIAN PROGRAM	Active transportation infrastructure and convenience are important factors in influencing people to utilize multi-modal options. The FWHA Bicycle and Pedestrian Program promotes and supports pedestrian and bicycle transportation through funding, policy guidance, program management, and resource development.
FWHA'S LIVABILITY INITIATIVE	The Livability Initiative aims to promote active and multi-modal transportation options and encourage improve community connectivity and cohesion. By enhancing access to services and opportunities, programs and policies can aid in promoting public health through activity, air quality, and other health related factors.
USDOT AND CDC'S TRANSPORTATION AND HEALTH TOOL	The tool provides easy access to data that practitioners can utilize to assess transportation health impacts. It provides resources and information to help agencies better understand links between health and transportation and improve public health through transportation planning and policy (*7*)

These programs, policies, and initiatives all contribute towards integrating health in transportation planning in the United States. By better understanding and analyzing the transportation factors that impact public health, transportation agencies and practitioners can better incorporate and implement projects and policies that promote and improve health outcomes for communities. As the federal government continues to support transportation infrastructure and multi-modal transit initiatives, we can expect that active transportation, public transportation, and other infrastructure related to safety and health will receive greater attention.

The *2021 Bipartisan Infrastructure Framework* contains plans to invest in clean transportation infrastructure (*23*). The framework includes health-related investments in transportation through the promotion and investment of public transit systems, pedestrian and bicycle infrastructure, and roadway and bridge infrastructure. With the new infrastructure emphasis of the Biden administration and the US Congress, and the focus on issues like equity, we expect transportation decision making to address health more explicitly through investments and emphasis in greater accessibility, multimodal transportation options, and other health-related transportation issues and factors (*5*).

State Context

The Texas transportation planning process is largely guided by federal and state legislation. This transportation framework allows for transportation decisions that consider and encourage the safety, efficiency, and development of surface transportation systems. Figure 3 and Figure 4 display the performance-based planning and programming framework that TxDOT utilizes (*8*).

Figure 3. Performance-based planning and programming framework (Source: TxDOT 2021)

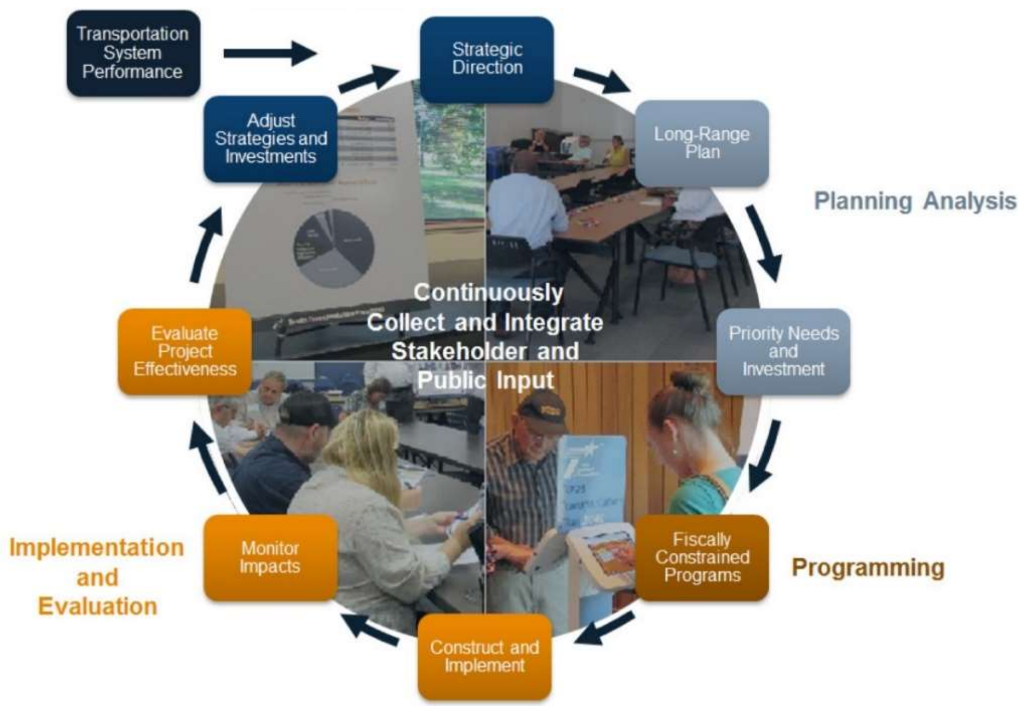

Figure 4. Transportation Planning Process in Texas

While the process is largely defined and shaped by federal legislation, TxDOT has the flexibility and opportunities to incorporate health as a major goal in its plans and projects, such as the Statewide Long Range Transportation Plan (SLRTP) and other transportation plans.

The SLRTP, mandated by federal law, prescribes forecasts demand over at least 20 years for transportation services and policies, strategies and/or future projects and forecasts demand for transportation services over a period of 20 years or more. The Statewide Transportation Improvement Program (STIP), also mandated by federal law, identifies statewide priorities for transportation projects, and is fiscally constrained to the projected available funding. The TxDOT Five-Year Strategic Plan (mandated by state law) is a five-year internal document covering TxDOT's goals, services, and transportation-related activities. The TxDOT Unified Transportation Program (UTP) is a 10-year programming document that lists the projects/programs planned to for development and implementation within the SLRTP.

On August 27, 2020, the Texas Transportation Commission adopted the TTP 2050. This is the state's second performance-based long-range transportation plan, following the TTP 2040. Similarly, to the TTP 2040, the current TTP addresses infrastructure inventory, safety, future services and needs, and performance goals/measures/targets. The TTP 2050 contains six goals (*9*).

- Promote Safety
- Preserve our Assets
- Optimize System Performance
- Deliver the Right Projects
- Foster Stewardship
    - Integrating environmental consideration into all TxDOT activities
- Focus on the Customer
    - Ensure public and stakeholders can see and understand TxDOT's decisions and provide feedback

While the TTP 2050 does not explicitly address health as a specific goal, some of the above goals contribute to and promote health. For example, environmental considerations could improve air quality through reductions in traffic congestions or increased physical activity and physical transport options for Texans (improve general health). Several areas of the TxDOT overall transportation planning process could consider and implement health considerations and enhance the linkage between transportation and health in Texas. TxDOT has the flexibility through their decision-making process to incorporate health into transportation decisions to better community health outcomes.

Potential Steps to Incorporate Health

While the USDOT has been promoting the integration of health into transportation, there is yet to be any federal requirements to explicitly include health in the transportation planning process and plans, TxDOT has the flexibility from a policy standpoint to develop and implement its own approach to health and transportation based on a state specific context. The USDOT does promote the integration of health into transportation planning through its Transportation and Health Tool and provides resources for transportation agencies to use to address health. TxDOT (and Texas Commission on Environmental Quality are involved and collaborate with the EPA and the FWHA to monitor air quality and determine attainment of air quality standards and conformity associated with transportation plans and proposed projects as pertains to public health impacts. TxDOT is responsible for three levels of transportation planning, summarized in

Table 6.

Table 6. TxDOT Transportation Planning Responsibilities in Texas.

OBJECTIVES	DESCRIPTION
STATEWIDE MULTIMODAL TRANSPORTATION PLANNING	SLRTP TxDOT strategic plan Statewide TIP UTP MPO Metropolitan Transpiration Plans MPO and TxDOT district TIPs Corridor Studies Texas Rail Plan Texas Airport System Plan Texas PORT Capital Plan
METROPOLITAN AREA TRANSPORTATION PLANS	TxDOT provides technical and other support, but these transportation plans are performed mostly by the MPOs in each area
RURAL TRANSPORTATION PLANNING	Rural (non-metropolitan) portion of the statewide plan, and which includes highway, bicycle pedestrian, general

aviation, inland waterway, passenger and freight rail, and public transportation components

Each step and objective within most, if not all, of these levels of state related transportation plans and processes can be modified to incorporate health considerations and utilize the fourteen pathways between health and transportation developed by CARTEEH. While there are elements of health considerations within TxDOT's TTP 2050 and other statewide transportation plans, TxDOT has the flexibility and opportunity to explicitly incorporate and emphasize public health considerations in these plans. In addition, many elements of the previous report (*Potential Framework for Integrating Air Quality and Health Considerations in Texas' Transportation Planning* FY 2016) produced by TTI provide potential frameworks, tools (i.e., Health Impact Assessments), and steps to incorporate health in transportation planning that are still relevant today (*5*).

Key Findings

The subsections above provide a comprehensive overview of the state of the practice, best practices, resources, and tools for addressing air quality and health. The six objectives provided by USDOT provide an excellent framework within which practitioners and policy makers can consider public health in the transportation planning process. The following section provides a case study evaluation that contextualizes and quantifies much of the guidance and best practices identified above.

CASE STUDY ASSESSMENT OF AUSTIN, TEXAS

TTI staff conducted a case study assessment of Austin Texas to show how air quality and health evaluations can be applied for planning and project development purposes to support Texas transportation practitioners. The following subsections provide the methodology used to conduct the case study assessment as well as results of the evaluation.

Case Study Methodology

The following sections provide an overview of the methodology used in the case study assessment.

Existing Transportation Network

TTI staff configured a mesoscopic dynamic traffic assignment (DTA) model for the current Austin network, as shown in Figure 5 (*24*). The mesoscopic model was iteratively updated and quality assured to reflect the latest changes within the network. The latest version of the Austin network was acquired, and once again, quality assured during the current study. The following details the quality assurance process.

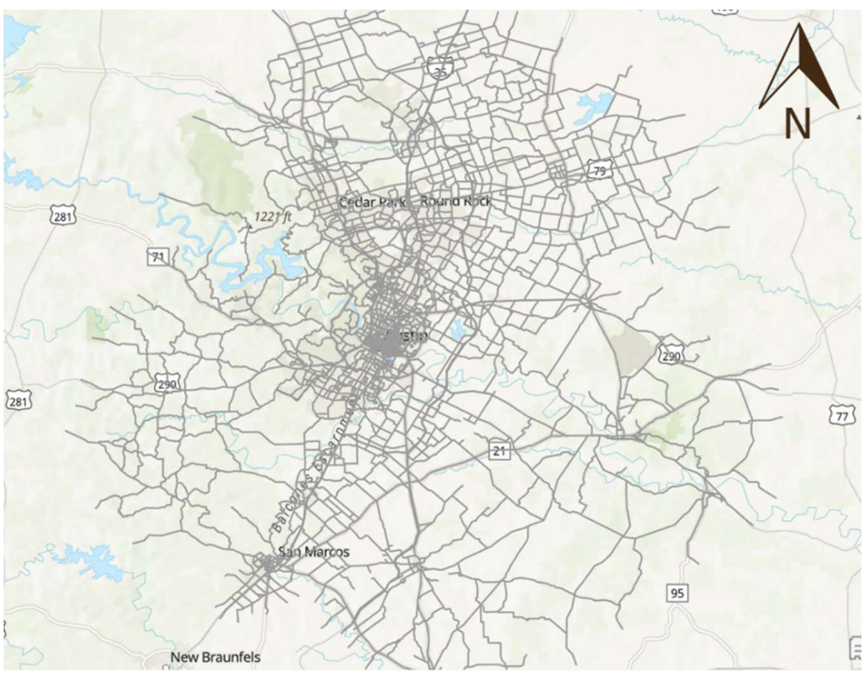

Figure 5. Austin network for the mesoscopic model.

The Austin network is represented by 1462 traffic analysis zones, 12,233 nodes, and 23,578 roadway links. Detailed characteristics of each link, including length, operational classification, and traffic flow model, in addition to the control systems, were incorporated into the model and tested. The accuracy of the links was confirmed at multiple aspects:

- Link curvature was matched to the real-world map.
- Link lengths were regenerated using the curvatures. The links with more than 40 ft or 10% difference between the old and new lengths were corrected. The total number of corrected links for length was 559.
- The link volumes from DTA model were confirmed for potential zero-values. There were 472 links with zero-values for volumes. The model may have a movement or link blockage. The identified links were checked one-by-one to remove any movement blockage. Relatively, zero-delay links were also confirmed for low volume on the link.
- Each link was confirmed to have a traffic flow model and capacity relative to the link type. After fixing some errors, there are currently 101 links with volume more than capacity at some time during the day. While this difference is small for most links due to the stochasticity of the model, there are a few links with more than 500 surge vehicles due to the random downstream blockage and their short length. Figure 6 shows the length distribution for the links with over capacity volume.

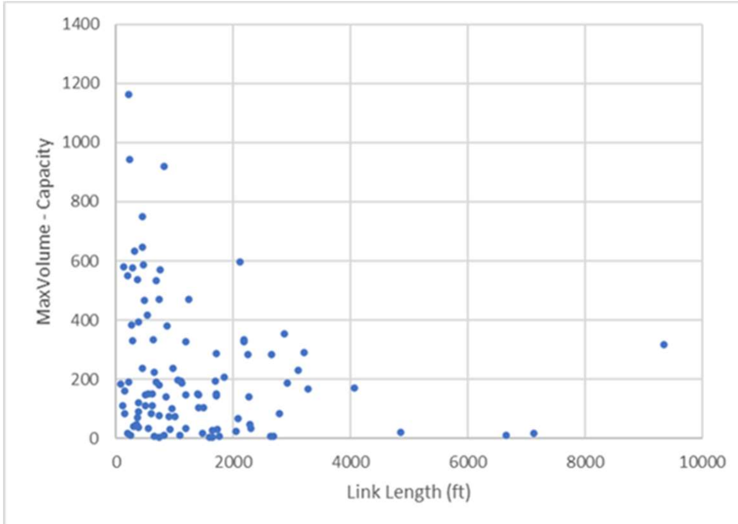

Figure 6. Traffic Flow Model Inaccuracy across Links.

- Finally, the tolled highways were confirmed for no free entrance or exit (if it should not), correct class of vehicles are using the toll facility, and correct toll rates.

The origin-destination demand data for the Austin region were developed using the Capitol Area Metropolitan Planning Organization (CAMPO) regional travel demand models (*24*). The demand data were a time series of the matrices of the number of trips between every pair of zones for each vehicle type aggregated for each hour of the day for single-occupancy light-duty vehicles (SOV), heavy-duty vehicles (HDV), and high-occupancy light-duty vehicles (HOV). Figure 7 underscores the high travel demand during the peak hour. A total of 5,332,323 daily trips are occurring in the Austin network.

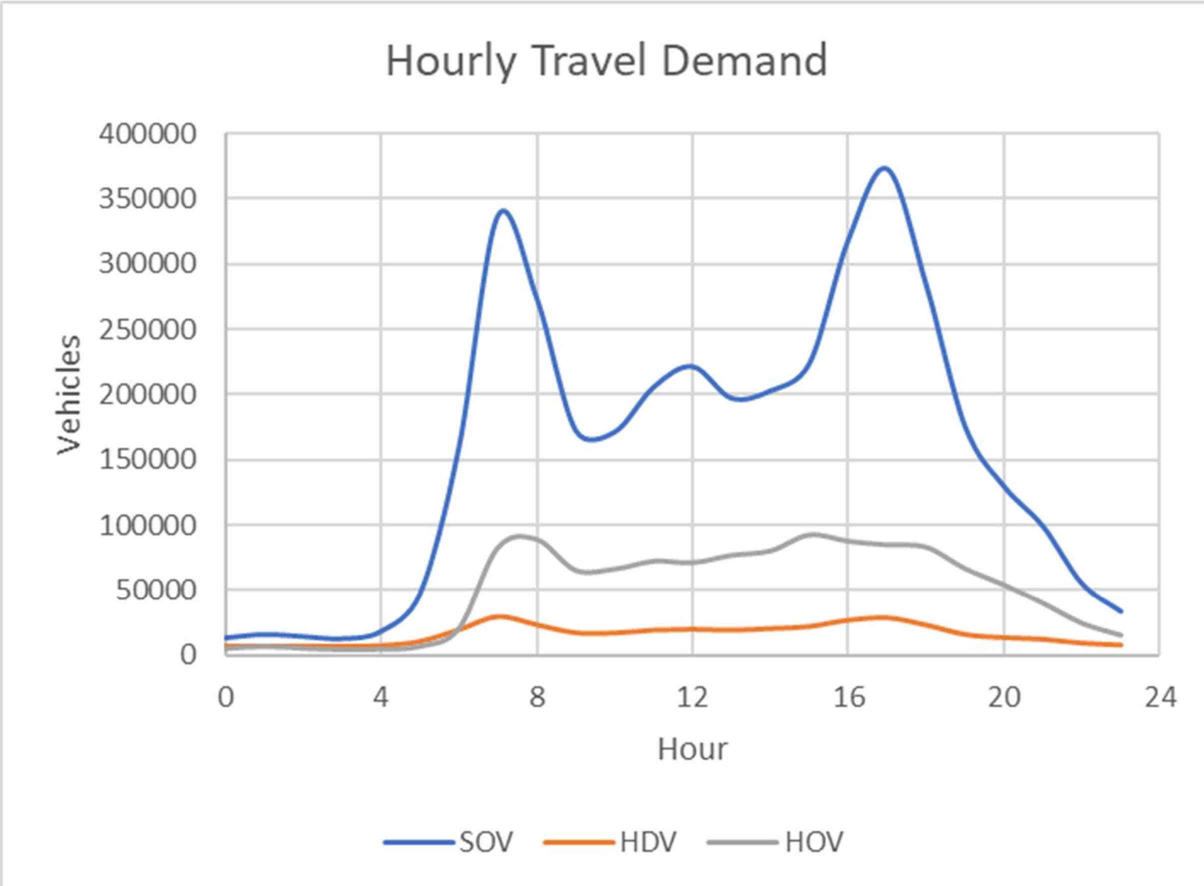

Figure 7. Travel demand data for the Austin region.

Managed Lane Configuration

The proposed managed lane is approximately 8 miles along I-35, from US 290 East to SH 71/Ben White Boulevard, corresponding to the I-35 Capital Express Central Project. The study added two non-tolled HOV lanes in each direction. The HOV lanes are separated from the general-purpose lanes, and the access is provided before and after each exit and entrance ramp to the I-35 facility. The managed lanes have the same traffic flow model and ground-level as the general-purpose lanes. Figure 8 shows the managed lane along I-35 from US 290 to SH 71 with multiple access points in the center.

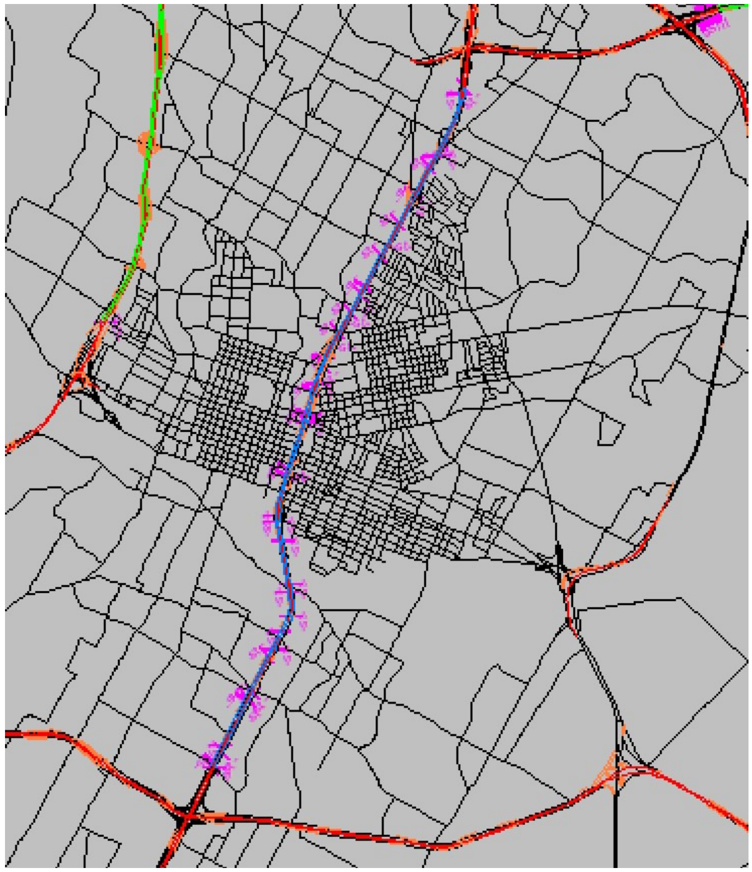

Figure 8. Proposed managed lane configuration along I-35

Platform to Assess Transportation, Health, and Sustainability (PATHS)

Researchers simulated the traffic, emissions, pollution dispersion, and health effects using the Platform to Assess Transportation, Health, and Sustainability, or PATHS (previously known as the Transportation and Emissions Modeling Platform for Optimization) , a modeling platform for integrating and automating a suite of transportation, energy, and emissions modules (*25*).

In PATHS, traffic patterns are simulated with a mesoscopic dynamic traffic assignment (DTA) model. The DTA model analyzes the movement of individual vehicles (as in microscopic models) while using macroscopic traffic flow theories without complicated vehicle interactions (*26*). Link-level vehicle emissions are modeled with MOVES-Matrix (*27*), a multi-dimensional emission rate database extracted from MOVES2014. Using link-level emissions, scripts were developed to automate the process of running EPA's American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD), which includes gathering information for meteorological inputs using

AERMET (American Meteorological Society/Environmental Protection Agency Regulatory Meteorological data preprocessor that incorporates air dispersion based on planetary boundary layer turbulence structure and scaling concept), placing receptors, and running AERMOD. The process produces region-wide pollutant dispersion maps for PM2.5 resulting from on road vehicle running emissions. The pollutant concentrations resulting from the dispersion of vehicle emissions are then translated to the ratio of asthma cases attributable to traffic related air pollution using well-recognized response functions (*28*). Interested readers are referred to the PATHS code repository for detailed documentation and source code: https://github.com/meitiv-tti/paths. Figure 9 illustrates the workflow of PATHS.

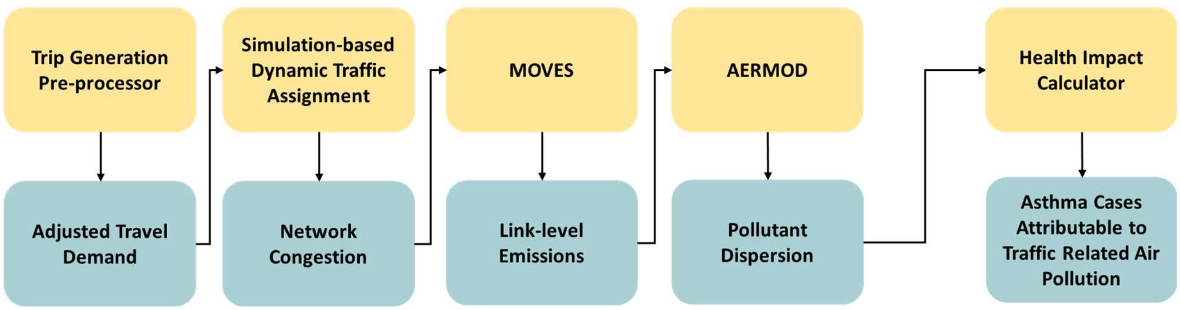

Figure 9. PATHS workflow

Results

This section presents the results from the full-chain analysis enabled by PATHS. These results are available through a live dashboard at http://54.159.31.130:3838/austin/.

Traffic

Based on the network configuration described in the Method section, the Managed Lane scenario shows increased delays throughout the network, as can be observed in Figure 10. Overall, total delay across the entire network increased by 7.7% and the increase is statistically significant at 95% confidence level based on 5 sets of simulation runs. There does not appear to be significant changes in vehicle miles traveled (VMT). Even though this phenomenon appears counterintuitive at first glance, it is worth noting that the traffic patterns showing here merely reflects the modeled traffic patterns by DynusT under the approximate network configuration. Previous studies on HOV lanes have shown that different HOV access types significantly impact the operational performance of the facilities (*29*) and that HOV lanes tend to have reduced effective capacities than general purpose lanes (*30*). Delay could also increase due to weaving to HOV lanes from entrance ramps and from HOV lanes to exit ramps. As such, it is plausible that delays would increase if the lanes are not optimally configured. This phenomenon warrants detailed engineering analyses through microscopic simulation.

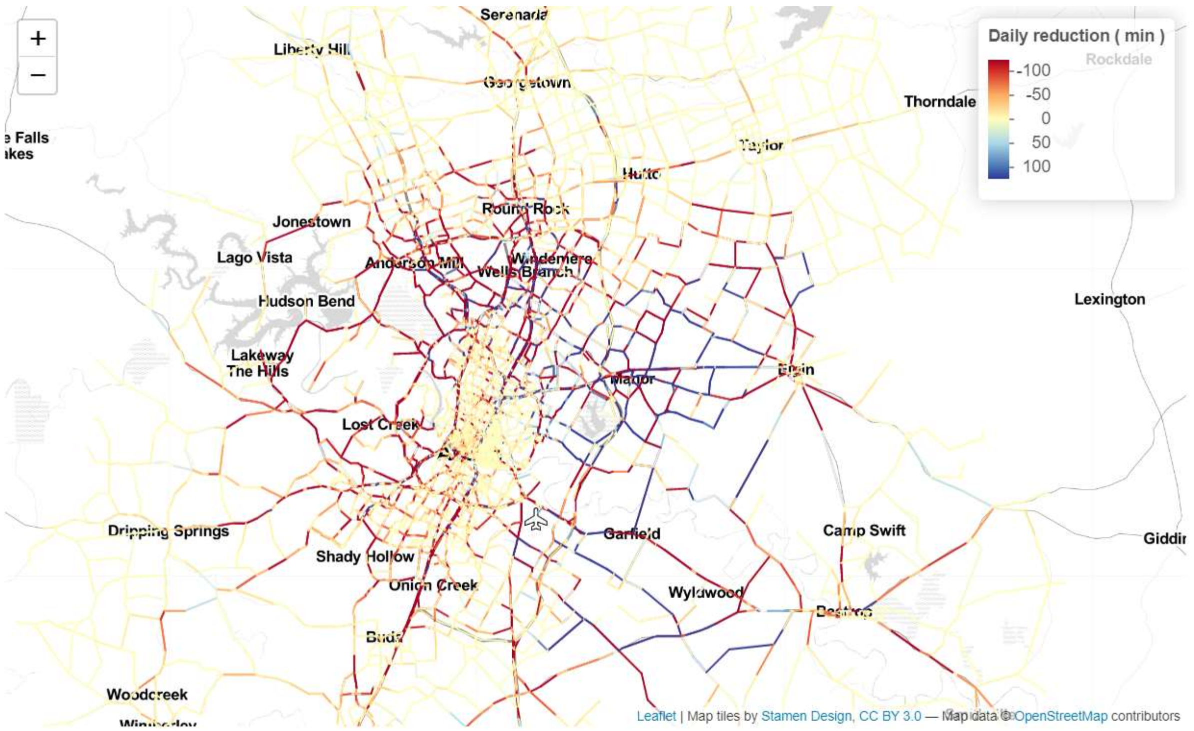

Figure 10. Changes in total delay (minutes) across the network

Emissions

Pollutant emissions changed as a result of changes in traffic (vehicle mix was held constant between base and ML scenarios). However, because low-speed and idle vehicle operations resulting from traffic delay only constitute a fraction of total vehicle operations, the changes in emissions are not as pronounced as the changes in delay. For example, the emissions of NOx in the modeling area increased by less than 1% and is not statistically significant at the 95% confidence level. The change in PM2.5 emissions is also negligible.

Figure 11 and Figure 12 depict the spatial variation of emission changes in different parts of the road network. These figures indicate that, even though the overall emissions changes are not significant, the distribution of the changes is not uniform across the network. Next, we explore the implications of such spatial distributions on pollutant dispersion and health.

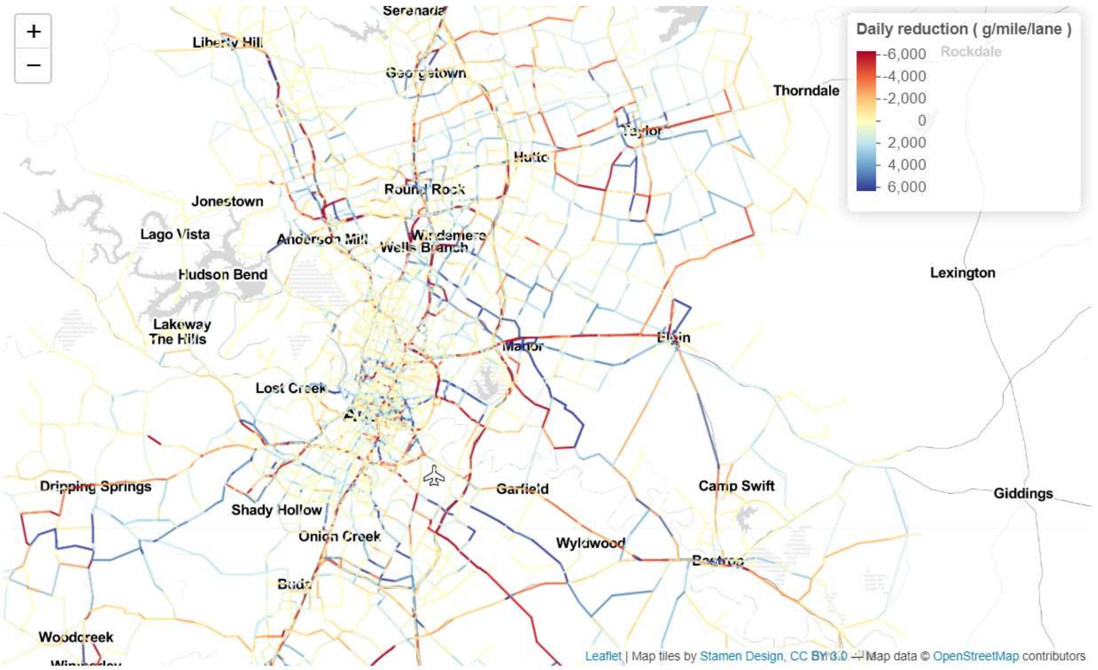

Figure 11. Changes in NOx emissions (grams/mile/lane) across the network

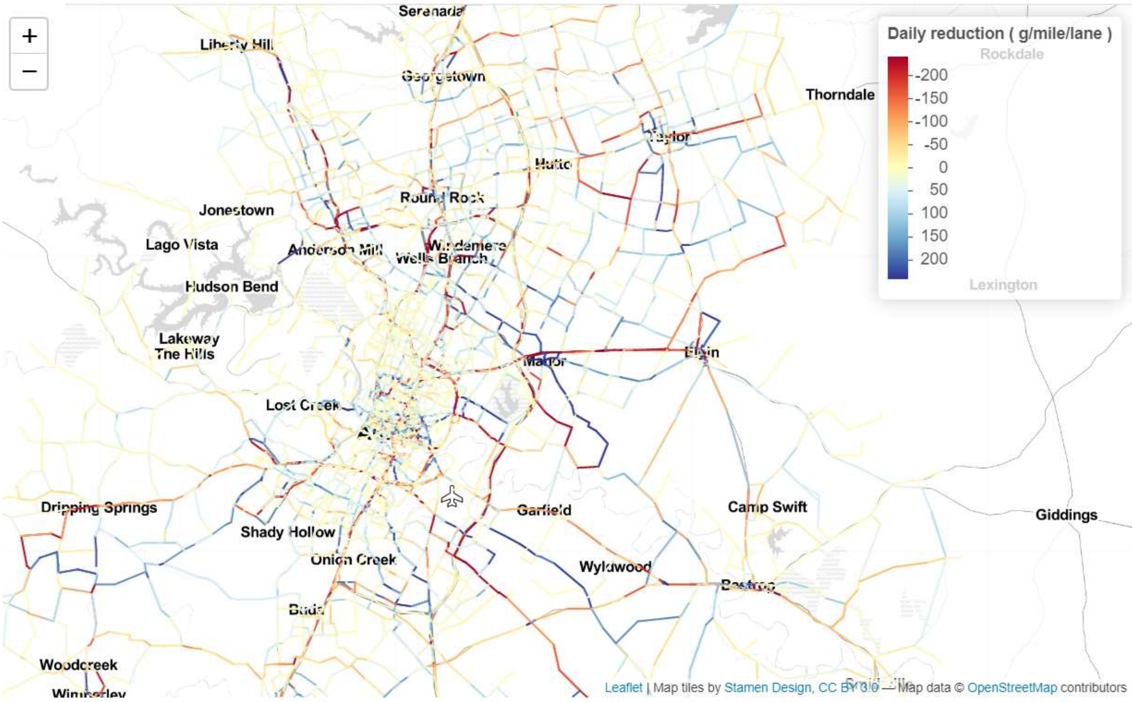

Figure 12. Changes in PM2.5 emissions (grams/mile/lane) across the network

Dispersion

Despite the relatively small changes in overall vehicle emissions, certain parts of the network and adjacent areas observed increased pollutant concentration resulting from emissions dispersion. Figure 13 shows the 24-hour average PM2.5 concentrations resulting from the dispersion of vehicle emissions. The figure indicates that the change in PM2.5 concentration ranges between negative one and positive one µg/m3, comparable to the ranges observed in similar studies done in other cities such as Chicago (*31*). The magnitude of change could have practical importance depending on background concentrations, considering that the NAAQS for PM2.5 is 12 µg/m3, so a small change from traffic contribution could mean an area would conform to or exceed NAAQS concentration levels.

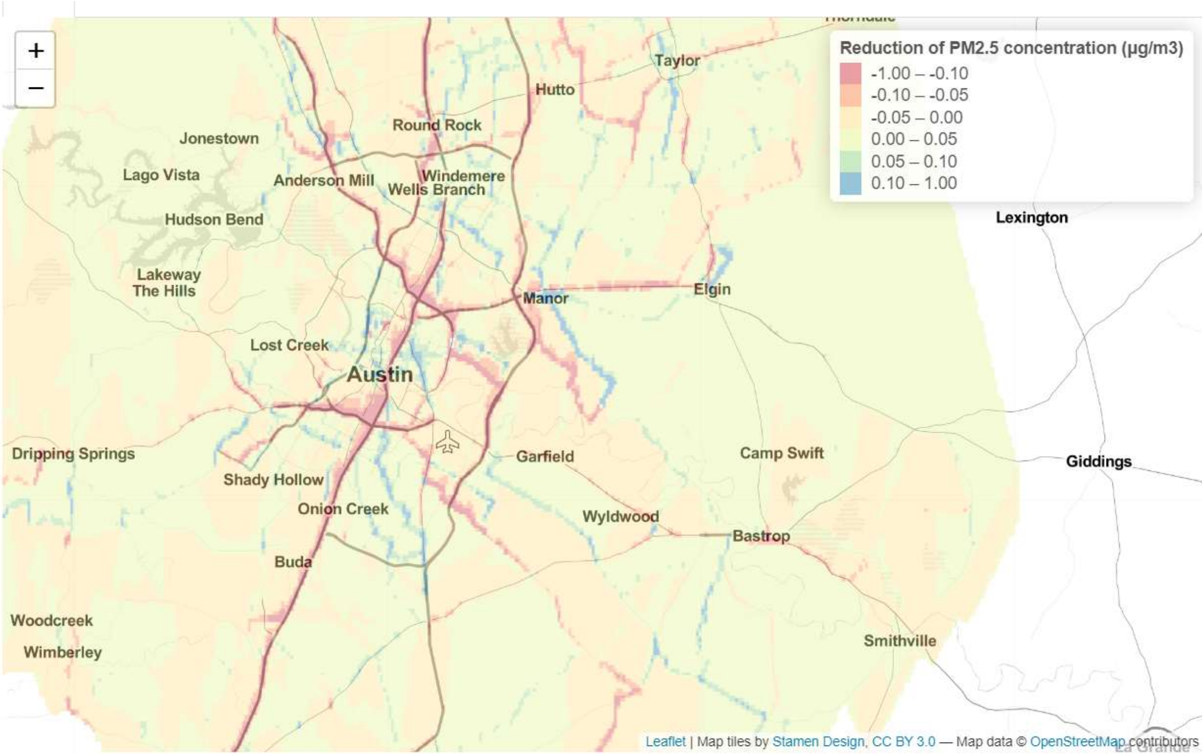

Figure 13. Changes in PM2.5 concentration from dispersion of tailpipe emissions (micrograms per cubic meter) across the network

Public Health

Changes in pollutant concentration can be translated in to changes in public health metrics. Here we present the changes in percentage of asthma cases attributable to TRAP in Figure 14. The results indicate that the magnitude of the relative change is small, but certain areas would observe an increase in the ratio of asthma cases attributable to TRAP while other areas would observe a decrease. The implication on environmental justice warrants further study.

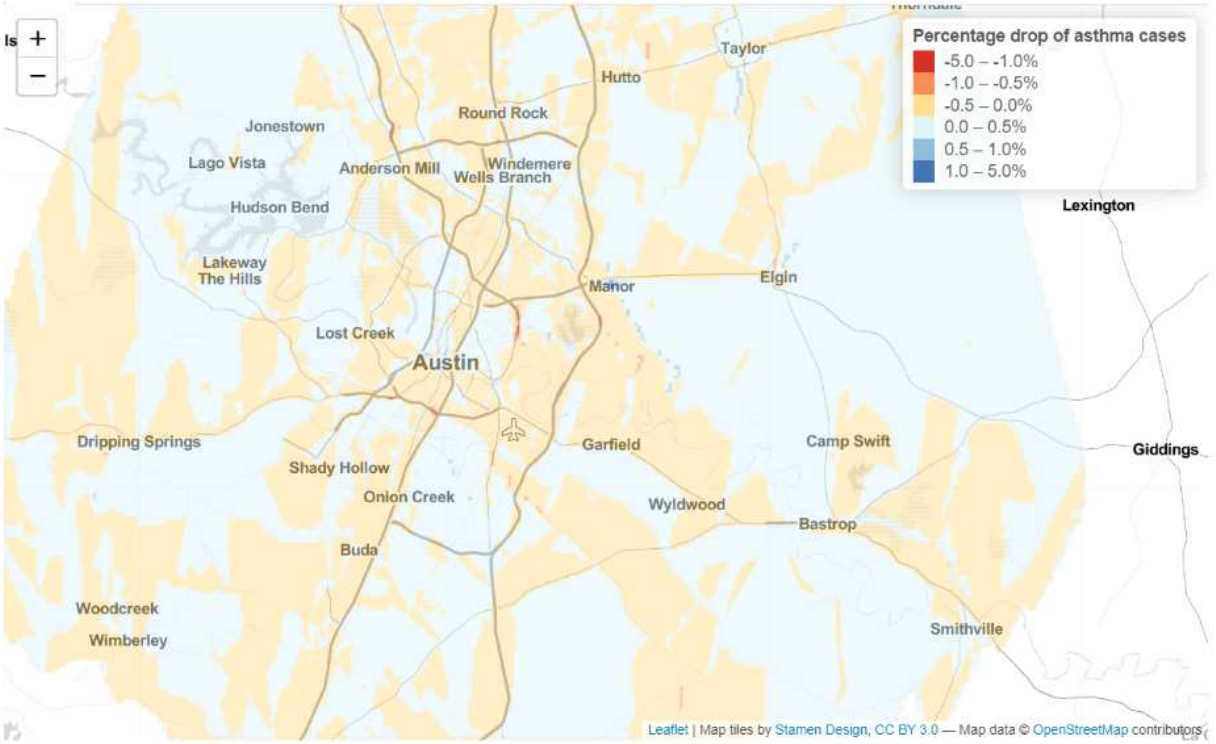

Figure 14. Percent changes in the ratio of asthma cases attributable to traffic-related air pollution across the network

Key Findings of Case Study Assessment

This case study demonstrated a full-chain comparison of no-build and build scenarios of HOV lanes on I-35 in Austin. The network configuration for the ML scenario was an approximation based on available public documents. Instead of reflecting the traffic conditions of detailed engineering designs, this case study provided an illustrative example of how changes in traffic resulting from managed lanes would propagate to emissions, pollutant dispersion, and public health.

Overall, the key traffic and emissions metrics did not exhibit significant changes in the entire Austin network, except for total delay, as summarized in

Table **7**. However, as illustrated in the maps, the distribution of these changes is not even in the entire metropolitan area. Some areas observed reductions in emissions, pollutant dispersion, and related asthma cases, while other areas observed increases. PATHS allows for rapid assessments of highly resolved spatial distribution of such environmental and health impacts from transportation infrastructure projects.

Table 7. Summary statistics between base and ML scenarios

Metric	Unit	Difference (Base - ML)	Percent Change	P-value
VMT	mile	24,900	0.0%	0.14
Total Delay	minute	-2,250,000	7.7%	0.16
Atmospheric CO2	kg	54,844	0.0%	0.77
NOx	kg	-1,512	0.1%	0.07
PM2.5	kg	-16	0.0%	0.50
PM10	kg	-17	0.0%	0.50

CONCLUSION

This report furthers work previously conducted by TTI regarding health and transportation in Texas. It also provides further insight into transportation's role in improving quality of life for Texans and provides TxDOT with an updated view of transportation and health. Current TxDOT transportation planning, programming, and project development processes include health considerations that are mandated by federal and state law, regulation, and/or policies. These health considerations mostly address air quality and safety concerns, and other public health concerns are still largely addressed through voluntary actions and preference, rather than requirement. However, should TxDOT decide to pursue greater consideration of health in transportation planning, their planning processes and frameworks provide flexibility to incorporate and promote public health.

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