Air Quality

I-270 Corridor Improvements

NEPA Environmental Assessment

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Acronyms and Abbreviations

Acronym	Definition
°F	degree(s) Fahrenheit
$\mu g/m^3$	microgram(s) per cubic meter
AADT	average annual daily traffic
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AQ-PLAG	*Air Quality Project-Level Analysis Guidance*
AQCC	Air Quality Control Commission
C.R.S.	Colorado Revised Statutes
CAA	Clean Air Act
CAPPCA	Colorado Air Pollution Prevention and Control Act
CCR	Code of Colorado Regulations
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFR	*Code of Federal Regulations*
CH_4	methane
cm	centimeter(s)
CO	carbon monoxide
CO_2	carbon dioxide
DM/NFR	Denver Metro/North Front Range
DRCOG	Denver Regional Council of Governments
EA	Environmental Assessment
EO	Executive Order
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FR	*Federal Register*
GHG	greenhouse gas
I-25	Interstate 25
I-270	Interstate 270
I-70	Interstate 70
I-76	Interstate 76
IAC	interagency consultation

Acronym	Definition
IRIS	Integrated Risk Information System
LOS	level of service
m	meter(s)
m/s	meter(s) per second
mph	mile(s) per hour
MPO	metropolitan planning organization
MSAT	mobile source air toxic
MVRTP	Metro Vision Regional Transportation Plan
NA	not available or the data do not satisfy minimum data completeness criteria
NAAQS	National Ambient Air Quality Standards
NEPA	National Environmental Policy Act
NHTSA	National Highway Traffic Safety Administration
N_2O	nitrous oxide
NO_2	nitrogen dioxide
NO_x	nitrogen oxides
O_3	ozone
Pb	lead
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
POAQC	project of air quality concern
ppb	part(s) per billion (by volume)
ppd	pound(s) per day
ppm	part(s) per million (by volume)
Roadmap	*Colorado Greenhouse Gas Pollution Reduction Roadmap*
RTP	Regional Transportation Plan
SIP	State Implementation Plan
SO_2	sulfur dioxide
TDM	Travel Demand Model
TIP	Transportation Improvement Program
tpd	ton(s) per day
tpy	ton(s) per year

Acronym	Definition
USDOT	U.S. Department of Transportation
VHT	vehicle hours traveled
VMT	vehicle miles traveled
VOC	volatile organic compound

1.0 Introduction

The Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA), in conjunction with local partners Adams County and Commerce City, are proposing improvements to 6 miles of Interstate 270 (I-270) in Adams County, Commerce City, and the City and County of Denver, Colorado, between Interstate 25 (I-25) and Interstate 70 (I-70) (Figure 1-1). CDOT and FHWA are preparing an Environmental Assessment (EA) for this project, referred to as the I-270 Corridor Improvements project. This report presents the federal and state regulations, methodology, existing air quality conditions, results of the air quality impact analysis, any necessary permits, and mitigation measures as appropriate. Sections 1 and 2 of the EA and EA Appendix B contain the project setting, purpose and need, and a detailed description of the No Action Alternative and Proposed Action.

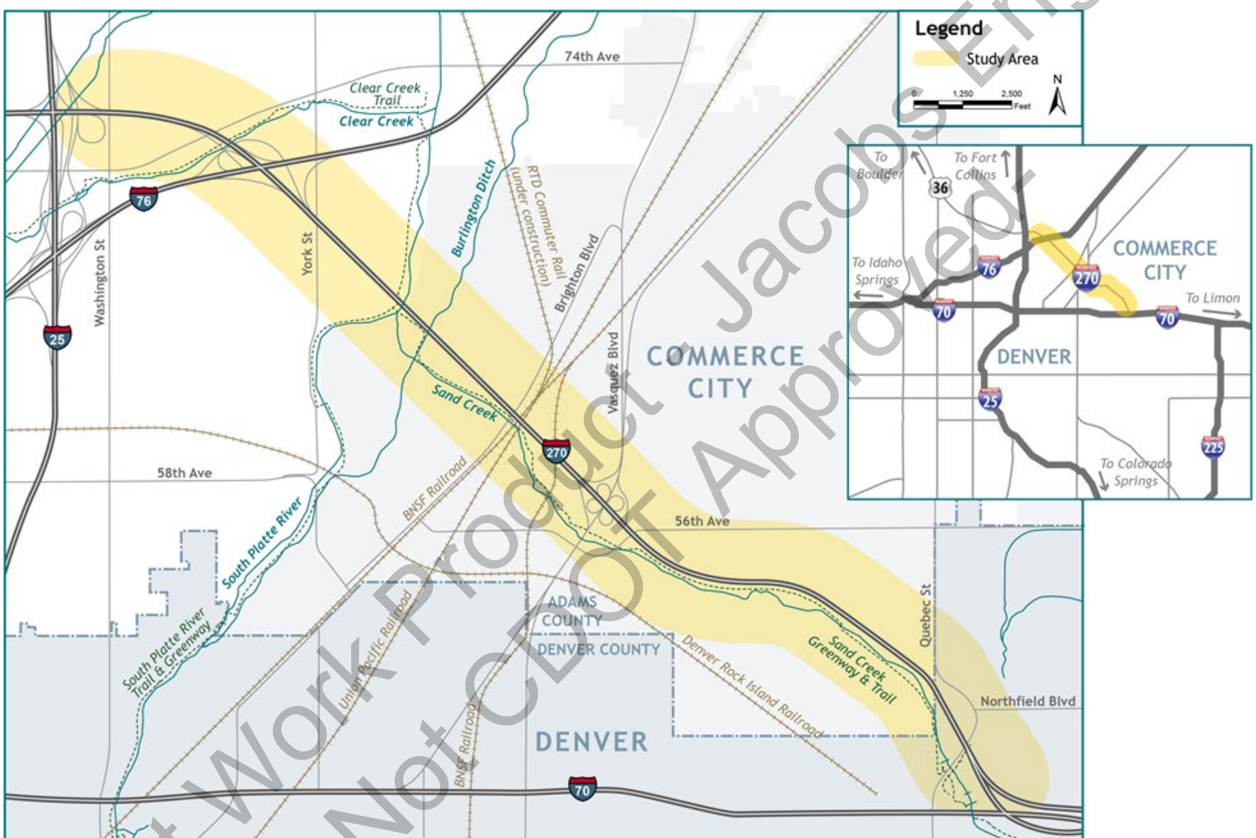

Figure 1-1. Project Location
Source: Jacobs

2.0 Regulatory Context

2.1 Federal Regulations

2.1.1 Clean Air Act and National Ambient Air Quality Standards

Air quality is regulated at the federal level through the Clean Air Act (CAA) (Title 42 *United States Code* Chapter 85). The U.S. Environmental Protection Agency (EPA) adopted the CAA in 1970 and its amendments in 1977 and 1990. Pursuant to the CAA, EPA has established nationwide air quality standards to protect public health and welfare. These standards, known as the National Ambient Air Quality Standards (NAAQS) (40 *Code of Federal Regulations* [CFR] 50), represent the maximum allowable concentrations of selected pollutants in ambient air above which could cause adverse effects on public health and welfare. NAAQS were developed for six criteria pollutants (Table 2-1): ozone (O_3), nitrogen dioxide (NO_2), carbon monoxide (CO), particulate matter less than 10 microns in aerodynamic diameter (PM_{10}) and particulate matter less than 2.5 microns in aerodynamic diameter ($PM_{2.5}$), sulfur dioxide (SO_2), and lead (Pb). NAAQS include Primary Standards that protect public health and Secondary Standards that protect public welfare (EPA 2020).

Table 2-1. National Ambient Air Quality Standards

Pollutant	Primary/Secondary	Averaging Time	Level	Form
CO	Primary	8 hours 1 hour	9 ppm 35 ppm	Not to be exceeded more than once per year
Pb	Primary and Secondary	Rolling 3-month average	0.15 $\mu g/m^3$ [a]	Not to be exceeded
NO_2	Primary Primary and Secondary	1 hour 1 year	100 ppb 53 ppb [b]	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years Annual mean
O_3	Primary and Secondary	8 hours	0.070 ppm [c]	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
$PM_{2.5}$	Primary Secondary Primary and Secondary	1 year 1 year 24 hours	12 $\mu g/m^3$ 15 $\mu g/m^3$ 35 $\mu g/m^3$	Annual mean, averaged over 3 years Annual mean, averaged over 3 years 98th percentile, averaged over 3 years
PM_{10}	Primary and Secondary	24 hours	150 $\mu g/m^3$	Not to be exceeded more than once per year on average over 3 years
SO_2	Primary Secondary	1 hour 3 hours	0.075 ppm [d] 0.5 ppm	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years Not to be exceeded more than once per year

Source: EPA 2020

[a] In areas designated nonattainment for the Pb standards prior to the promulgation of the current (2008) standards, and for which implementation plans to attain or maintain the current (2008) standards have not been submitted and approved, the previous standards (1.5 $\mu g/m^3$ as a calendar quarter average) also remain in effect.

[b] The level of the annual NO_2 standard is 0.053 ppm. It is shown here in terms of ppb for the purposes of clearer comparison to the 1-hour standard level.

[c] Final rule signed October 1, 2015, and effective December 28, 2015. The previous (2008) O_3 standards additionally remain in effect in some areas. Revocation of the previous (2008) O_3 standards and transitioning to the current (2015) standards will be addressed in the implementation rule for the current standards.

[d] The previous SO_2 standards (0.14 ppm 24-hour and 0.03 ppm annual) will additionally remain in effect in certain areas: (1) any area for which it is not yet 1 year since the effective date of designation under the current (2010) standards, and (2) any area for which an implementation plan providing for attainment of the current (2010) standard has not been submitted and approved and which is designated nonattainment under the previous SO_2 standards or is not meeting the requirements of an SIP call under the previous SO_2 standards (40 CFR 50.4(3)). An SIP call is an EPA action requiring a state to resubmit all or part of its SIP to demonstrate attainment of the required NAAQS.

$\mu g/m^3$ = microgram(s) per cubic meter
ppb = part(s) per billion (by volume)
ppm = part(s) per million (by volume)
SIP = State Implementation Plan

The CAA requires EPA to classify regions with respect to each criteria pollutant, depending on whether the area's monitored air quality meets the NAAQS. A region that is meeting the NAAQS for a given pollutant is designated as being in "attainment" for that pollutant. If the region violates (does not meet) the NAAQS for a given pollutant, it is designated as being in "nonattainment" for that pollutant. Under Section 175A of the CAA, maintenance plans are developed to show how the area is maintaining the

NAAQS. EPA will make the redesignation of maintenance to attainment for an area after the area shows pollutant concentrations stay lower than the NAAQS for 20 years.

The 1977 CAA Amendments required each state to develop and maintain a State Implementation Plan (SIP) for each criteria pollutant that violates the applicable NAAQS. The SIP serves as a tool to avoid and minimize emissions of pollutants and to achieve compliance with the NAAQS. In 1990, the CAA was amended to strengthen regulation of both stationary and mobile emission sources for criteria pollutants.

2.1.2 Transportation Conformity

The transportation conformity requirement is based on CAA Section 176(c), which prohibits the U.S. Department of Transportation (USDOT) and other federal agencies from funding, authorizing, or approving plans, programs, or projects that do not conform to the SIP for attaining the NAAQS for CO, NO_2, O_3, PM_{10}, and $PM_{2.5}$. Conformity requirements apply only in nonattainment and maintenance areas of the NAAQS. Demonstration of conformity with the CAA takes place on two levels for transportation projects: the regional or planning and programming level, and the project level.

Regional Conformity: Regional conformity is concerned with how well the regional transportation system supports plans for attaining the NAAQS. Regional conformity is based on emission analysis of Regional Transportation Plans (RTPs) and federal Transportation Improvement Programs (TIPs) that include the transportation projects planned for a region over a period of at least 20 years for the RTP and 4 years for the TIP. RTP and TIP conformity uses travel demand and emission models to determine whether the implementation of those projects would conform to motor vehicle emission budgets or other tests at various analysis years, showing that requirements of the CAA and the SIP are met. If the design concept, scope, and "open-to-traffic" schedule of a proposed transportation project are consistent with the descriptions in the conforming RTP and TIP, then the proposed project meets regional conformity requirements.

The Denver Regional Council of Governments (DRCOG) is the federally designated metropolitan planning organization (MPO) responsible for transportation planning for the Denver metropolitan region, where the I-270 Corridor Improvements project is located.

Project-level Conformity: Project-level conformity is concerned with how well the project will attain the NAAQS. At this level, a project must not do the following:

- Cause or contribute to any new localized CO and PM_{10}/$PM_{2.5}$ violations
- Increase the frequency or severity of any existing CO and PM_{10}/$PM_{2.5}$ violations
- Delay timely attainment of any NAAQS or any required interim emission reductions, or other milestones in CO and PM_{10}/$PM_{2.5}$ nonattainment and maintenance areas

The conformity demonstration is not required for construction-related activities that occur only during the construction phase and last 5 years or less at any individual site (40 CFR 93.123(c)(5)).

Per 40 CFR 93.102, the project is subject to the transportation conformity requirements and may require "hot spot" analysis because it is federally funded and is located in an area that is in maintenance for CO and PM_{10}. Detailed methodologies for conformity demonstration are discussed in Section 5.1. As of January 15, 2022, transportation conformity requirements for CO no longer apply to the Denver-Boulder CO maintenance area. Therefore, a hot spot analysis for CO is not required.

2.1.3 Mobile Source Air Toxics

In addition to the criteria pollutants, EPA also regulates air toxic emissions. Controlling air toxic emissions became a national priority with the passage of the CAA Amendments of 1990, whereby Congress mandated that EPA regulate 188 air toxics, also known as hazardous air pollutants. EPA assessed this expansive list in its latest rule on the Control of Hazardous Air Pollutants From Mobile Sources (*Federal Register* [FR], Vol. 72, No. 37, page 8430, February 26, 2007), and identified a group of

93 compounds emitted from mobile sources that are listed in EPA's Integrated Risk Information System (IRIS) (EPA 2021a). In addition, EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers or contributors and noncancer hazard contributors from EPA's *National Air Toxics Assessment* (EPA 2014). These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics (MSATs), the list is subject to change and may be adjusted in consideration of future EPA rules. Unlike the criteria pollutants, MSATs do not have ambient air quality standards. Potential MSAT effects from the project operation were evaluated following the FHWA memorandum titled *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2016) and are discussed further in Section 5.2.2.

2.1.4 Greenhouse Gases

Greenhouse gases (GHGs) include both naturally occurring and anthropogenic gases, such as carbon dioxide (CO_2), methane (CH_4), nitrous oxide (N_2O), hydrochlorofluorocarbons, perfluorocarbons, and sulfur hexafluoride. The accumulation of GHGs in the atmosphere influences the long-term range of average atmospheric temperatures. These gases trap the energy from the sun and help maintain the temperature of the Earth's surface, creating a process known as the greenhouse effect.

EPA's authority to regulate GHG emissions stems from the U.S. Supreme Court decision in *Massachusetts v. EPA* (2007). The Supreme Court ruled that GHGs meet the definition of air pollutants under the existing CAA and must be regulated if these gases could be reasonably anticipated to endanger public health or welfare. EPA and the National Highway Traffic Safety Administration (NHTSA) took coordinated steps to enable the production of a new generation of clean vehicles with reduced GHG emissions and improved fuel efficiency from on-road vehicles and engines. EPA in conjunction with the NHTSA issued the first of a series of GHG emission standards for new cars and light-duty vehicles in April 2010 and substantially increased the fuel economy standards for all new passenger cars and light trucks sold in the country. In April 2020, the NHTSA and EPA issued the Safer Affordable Fuel-Efficient Vehicles Rule to amend the corporate average fuel economy and tailpipe CO_2 emissions standards for passenger cars and light trucks covering model years 2021 to 2026 (85 FR 24174). The updated standards will result in avoiding more than 3 billion tons of GHG emissions through 2050 (86 FR 74434).

In October 2016, NHTSA and EPA issued a Final Rule for "Phase 2" for medium- and heavy-duty vehicles to improve fuel efficiency and cut carbon pollution (that is, GHG emissions). The agencies estimate that the standards will save up to 2 billion barrels of oil and reduce CO_2 emissions by up to 1.1 billion metric tons over the lifetimes of model year 2018 to 2027 vehicles.

In March 2017, Executive Order (EO) 13783, "Promoting Energy Independence and Economic Growth," was signed. EO 13783 orders all federal agencies to apply cost-benefit analyses to regulations of GHG emissions and evaluations of the social cost of carbon, N_2O, and CH_4.

2.2 State and Local Laws and Regulations

2.2.1 Criteria Pollutants

The Colorado Air Pollution Prevention and Control Act (CAPPCA) of 1992 (Colorado Revised Statutes [C.R.S.] Section 25-7-101) was passed to foster the health, welfare, convenience, and comfort of citizens and visitors within the State of Colorado and to facilitate the enjoyment and use of the scenic and natural resources of the state. The purpose of this act is to require use of available practical methods to reduce, prevent, and control air pollution; require development of an air quality control program; and maintain a cooperative program between state and local units of government for the State of Colorado.

At the state level, air quality impacts from Colorado transportation projects are regulated by state regulations including the Code of Colorado Regulations (CCR) that were adopted by the Colorado Air Quality Control Commission (AQCC) of the Colorado Department of Public Health and Environment (CDPHE), such as the following:

- Regulation Number 1 (5 CCR 1001-3): Emission Control for Particulate Matter, Smoke, Carbon Monoxide, and Sulfur Oxides
- Regulation Number 3 (5 CCR 1001-5): Stationary Source Permitting and Air Pollutant Emission Notice Requirements
- Regulation Number 10 (5 CCR 1001-12): Criteria for Analysis of Transportation Conformity

The AQCC oversees Colorado's air quality program in accordance with the CAPPCA. The commission is responsible for adopting an air quality program that promotes clean and health air for Colorado's citizens and visitors, protects Colorado's scenic and natural resources, and promotes statewide GHG pollution abatement. The commission's air quality regulations help to ensure Colorado meets clean air goals and federal requirements.

The Air Pollution Control Division (APCD) of the CDPHE coordinates development of motor vehicle emission budgets, develops SIPs, reviews project-level air quality conformity determinations for some transportation projects, maintains state and local air monitoring stations, and handles air-related permitting and inspections.

2.2.2 Transportation Pollutants

C.R.S. 43-1-128 was signed on June 17, 2021, which requires the planning, funding, development, construction, maintenance, and supervision of a sustainable transportation system in Colorado. The State of Colorado would work to create new funding to preserve, improve, and expand existing transportation infrastructure, develop modernized infrastructure to support adoption of electric motor vehicles, and mitigate environmental and health impacts related to transportation system use. C.R.S. 43-1-128 includes additional requirements for CDOT and the MPOs to engage in community involvement, modeling, and monitoring when assessing potential environmental impacts of transportation capacity projects during the environmental study process. The requirements specific to this project are defined in Section 4 of C.R.S. 43-1-128 and include the following[1]:

- Use EPA-approved models to determine air pollutant emissions impacts for the planned project and provide monitoring and measurement of criteria pollutants prior to construction.
- Develop and implement a PM construction plan to provide continuous monitoring and transparent public reporting of concentrations, public alerts issued as soon as possible when exceedance events occur, and action plans to address emission levels on construction projects prior to exceedances with particular focus on disproportionately impacted communities.
- Develop and implement a plan to mitigate air quality impacts on communities, including but not limited to disproportionately impacted communities adjacent to the project, with particular focus where feasible on mitigation of fine PM pollution.

In March 2021, CDOT and CDPHE began a research project that includes the I-270 corridor within the study area. The purpose of this research project was to study how future I-270 construction activities impact air quality. The research team conducted baseline monitoring (pre-construction) to determine the existing air quality before construction activities commence. Criteria pollutant concentrations are currently being

[1] Of these requirements, this report discusses the modeling requirement in detail, because it is completed during NEPA. The remaining requirements, which are part of the construction phase, are not discussed in detail in this report. They will be discussed in a later project-specific air quality construction plan.

monitored for PM_{10}, $PM_{2.5}$, NO_2, and volatile organic compounds (VOCs) within the study area during the pre-construction phase of the research project. The C.R.S. 43-1-128 requirement is being met by this parallel air quality monitoring research project that is anticipated to run until November 2025.

2.2.3 Greenhouse Gases

As required by Colorado House Bill 19-1261 (Climate Action Plan to Reduce Pollution), the state established statewide GHG pollution reduction goals to reduce 2025 GHG emissions by at least 26 percent, 2030 GHG emissions by at least 50 percent, and 2050 GHG emissions by at least 90 percent of the levels that existed in 2005. In an effort to achieve these goals, the governor directed state agencies to develop the *Colorado Greenhouse Gas Pollution Reduction Roadmap* (Roadmap) (Polis 2021). The Roadmap identified nine different strategies for transportation to achieve the goals established in the Climate Action Plan to Reduce Pollution. One of these strategies is to adopt a new GHG pollution rule. With the passage of C.R.S. 43-1-128 and the key recommendation from the Roadmap to adopt a GHG rule, CDOT established a new GHG Planning Standard, Title 2 of the Code of Colorado Regulations (CCR) 601-22. Per C.R.S. 43-1-128, Section 3, CDOT and the MPO are required to do the following:

- Implement relevant rules and regulations issued pursuant to Section 25-7-105.
- Otherwise reduce GHG emissions to help achieve the statewide GHG pollution reduction targets established in Section 25-7-102(2)(g).
- Modify their guidance documents to ensure that at least the same level of analytical scrutiny is given to GHG pollutants as is given to other air pollutants of concern in the state including consideration of the impact on emission of GHG pollutants of induced demand resulting from regionally significant transportation capacity projects alongside traffic modeling.
- Consider the role of land use in the transportation planning process and develop strategies to encourage land use decisions that reduce vehicle miles traveled (VMT) and GHG emissions.

3.0 Methods

The air quality analysis was completed based on the requirements of the National Environmental Policy Act (NEPA), the conformity provisions of the CAA Amendments, FHWA's MSAT Guidance (FHWA 2016), C.R.S. 43-1-128, and CDOT's *Air Quality Project-Level Analysis Guidance* (AQ-PLAG), Version 1 (CDOT 2019a).

The following briefly describes the data gathered and the approach of the air quality analyses for this project. More detailed information on the methodology for the analyses and modeling is included in Sections 4.0 and 5.0 and in the Air Quality Analysis Work Plan in Appendix A.

3.1 Data Gathering

The following data were gathered and reviewed to perform the air quality analysis and modeling:

- Existing air quality monitoring and climate data
- Traffic data:
  - Average annual daily traffic (AADT)
  - Peak hour traffic
  - VMT
  - Vehicle hours traveled (VHT)
  - Level of service (LOS)
  - Diesel truck percentages
  - Vehicle speeds
  - Four time periods per day to support PM analysis

- Proposed roadway alignment design files
- Data obtained from APCD for emissions and air dispersion modeling purposes (emission factors, background concentrations, persistence factors, and meteorological data)
- DRCOG Travel Demand Model (TDM)
- *2050 Metro Vision Regional Transportation Plan* (MVRTP) and 2022-2025 TIP

The traffic analysis for the project used 2016 for the base year (for details, refer to Appendix B of the *Traffic Technical Report*, provided under separate cover for this project). The air quality analysis is required to use the latest planning assumptions and therefore used 2050 traffic data for the design year. Appendix A includes more detailed information on the 2050 traffic data used for the air quality analysis (refer to Appendix A, Attachment 2 of the Air Quality Analysis Work Plan).

3.2 Analysis Approach

The air quality impacts analysis considered whether each of the alternatives would meet the following criteria:

- Meet regional transportation conformity based on inclusion in the RTP and TIP.
- Meet project-level transportation conformity based on the following:
  - Transportation conformity interagency consultation (IAC) processes to determine conformity requirements for PM_{10}
  - Quantitative PM_{10} hot spot modeling, which would be required if the project is determined to be a project of air quality concern (POAQC)
- Comply with NEPA based on the potential for the following:
  - Impacts from emission increases of criteria pollutants
  - MSAT effects from project operation
  - GHG emissions from project operation
  - Temporary construction emissions
- Comply with C.R.S. 43-1-128, based on the following:
  - Use EPA models to determine air pollutant emissions impacts.
  - Monitor and measure criteria pollutants prior to construction.[2]
  - Develop and implement a PM construction plan for the following:
    - Continuous monitoring
    - Public alerts
    - Action plan to address exceedances with focus on disproportionately impacted communities
  - Develop and implement a plan to mitigate air quality impacts (PM pollution).

4.0 Existing Conditions

This section discusses the atmospheric conditions of the study area, description of air pollutants, attainment status, monitored ambient air pollutant concentrations, and sensitive receptors located within the study area that could be potentially impacted by the proposed project.

4.1 Climate and Topography

The project is located in the Denver area that lies in the South Platte River Valley, east of the foothills of the Rocky Mountains. The region stands on the High Plains and with hills surrounding the western, northern, and southern regions. The region has a semi-arid, continental climate with hot summers and

[2] This C.R.S. requirement is being met with a parallel research project (Section 2.2).

cold winters. The nearby mountain areas influence the climate and produce microclimates of subtropical and humid continental nature in the adjacent regions of Denver. The difference between the daily high and low temperatures is extreme due to high elevation and aridness. Summers are hot and the high temperatures in the peak of July register above 90 degrees Fahrenheit (°F) for many days, and the highest temperature over the past 30 years is 105°F. Annual precipitation is approximately 14.5 inches on average, with 70 percent occurring during the summer. Winters are cold with plenty of snow; average annual snowfall is 54.8 inches in Denver area, usually occur from October to April. December has the lowest temperatures during the year with an average minimum temperature at 17.7°F (NWS 2021). Chinook winds bring warmness during the winter. Tornadoes occur on the eastern side of Denver during spring and summer.

4.2 Existing Air Quality

4.2.1 Criteria Pollutants

Transportation projects have the potential to emit criteria air pollutants. Their effects on humans are discussed in the following paragraphs, except for lead and SO_2. Lead and SO_2 emissions would be negligible from project activities and are not further discussed in this section.

Ozone

Ozone is a colorless gas that is not directly emitted as a pollutant but is formed when VOCs and nitrogen oxides (NO_x) react in the presence of sunlight. Low wind speeds or stagnant air mixed with warm temperatures typically provide optimum conditions for the formation of ozone. Because ozone formation does not occur quickly, ozone concentrations often peak downwind of the emission source. As a result, ozone is of regional concern because it impacts a larger area. When inhaled, ozone irritates and damages the respiratory system.

Nitrogen Oxides

NO_x is a generic name for the group of highly reactive gases that contain nitrogen and oxygen in varying amounts. Many types of NO_x molecules are colorless and odorless. However, when combined with particles in the air, NO_2—a common pollutant—can often be seen as a reddish-brown layer over many urban areas.

NO_x forms when fuel is burned at high temperatures. Typical artificial sources of NO_x include motor vehicles; fossil-fueled electricity generation utilities; and other industrial, commercial, and residential sources that burn fuels. NO_x can harm humans by affecting the respiratory system. Small particles can penetrate the sensitive parts of the lungs, cause or worsen respiratory disease, and aggravate existing heart conditions. As discussed previously, O_3 is formed when NO_x and hydrocarbons (VOCs) react with sunlight.

Volatile Organic Compounds

VOCs are a group of chemicals that react with NO_x and hydrocarbons in the presence of heat and sunlight to form ozone. Examples of VOCs include gasoline fumes and oil-based paints. This group of chemicals does not include CH_4 or other compounds determined by EPA to have negligible photochemical reactivity.

Particulate Matter

PM, which is defined as particles suspended in a gas, is often a mixture of substances, including metals, nitrates, organic compounds, and complex mixtures (for example, diesel exhaust and soil). PM can be traced back to both natural and artificial sources. The most common sources of natural PM are dust and fires, whereas the most common artificial source is the combustion of fossil fuels.

PM causes irritation to the human respiratory system when inhaled. The extent of health risks due to PM exposure can be determined by the size of the particles. The smaller the particles, the deeper they can be deposited in the lungs. PM is often grouped into two categories—PM_{10} and $PM_{2.5}$.

Carbon Monoxide

CO is a colorless, odorless, and tasteless gas that is directly emitted as a by-product of combustion. CO concentrations tend to be localized to the source, and the highest concentrations are associated with cold, stagnant weather conditions. CO is readily absorbed through the lungs into the blood, where it reduces the ability of the blood to carry oxygen. This can lead to serious tissue damage or even death.

4.2.2 Attainment Status and State Plans

The project is located in Adams County and the City and County of Denver. The study area is in the Denver Metro/North Front Range (DM/NFR) nonattainment area for the 2008 and 2015 ozone NAAQS (RAQC 2021a, 2021b). In December 2019, EPA reclassified the DM/NFR nonattainment area to serious under the 2008 8-hour ozone NAAQS. The AQCC approved the *Serious State Implementation Plan for the Denver Metro and North Front Range Ozone Nonattainment Area* in December 2020, and it was submitted to EPA in March 2021 following legislative approval (RAQC 2021a).

The study area is in the Denver Metro maintenance area for the 1987 PM_{10} NAAQS. EPA redesignated the Denver metropolitan area as an attainment/maintenance area and approved the maintenance plan, *Particulate Matter (PM_{10}) Redesignation Request and Maintenance Plan for the Denver Metropolitan Area*, on September 16, 2002, with an effective date of October 16, 2002 (67 FR 58335). The 20-year maintenance period for the area will end on October 16, 2022, and after that the area will be in attainment and no longer be subject to transportation conformity demonstration for PM_{10}.

The study area is in the Denver-Boulder area for the 1971 CO NAAQS. EPA redesignated the Denver-Boulder area as an attainment/maintenance area and approved the maintenance plan, *Carbon Monoxide Redesignation Request and Maintenance Plan for the Denver Metropolitan Area*, on December 14, 2001, with an effective date of January 14, 2002 (66 FR 64751). The 20-year maintenance period for the area ended on January 14, 2022, and the area is in attainment and no longer subject to transportation conformity demonstration for CO.

The study area is in attainment for all other criteria pollutants.

Transportation control measures included as part of the PM_{10} SIP that relate to I-270, such as street sanding and sweeping activities, would continue to be implemented with the No Action Alternative and Proposed Action.

4.2.3 Air Pollutant Monitoring Data

Per the AQ-PLAG, monitoring data are provided from nearby stations that best represent the study area for pollutants for which the project has nonattainment and/or maintenance areas. The CDPHE operates several air pollutant monitoring stations that are approved by EPA in Adams County and the City and County of Denver. The closest station is located at 4201 72nd Avenue in Commerce City (Commerce), approximately 1.1 miles east to the study area, and is considered to represent the air quality conditions of the study area. The Commerce station measures PM_{10} and $PM_{2.5}$ concentrations only. Air quality data of other pollutants were obtained from other nearby stations located at 7275 Birch Street in Commerce City (Birch), approximately 1.2 miles east to the study area and 3174 East 78th Avenue in Welby (Welby), approximately 1.3 miles northeast to the study area.

Figure 4-1 depicts the location of the monitoring stations. Ambient air quality concentrations of criteria pollutants measured during 2018 to 2021 are summarized in Table 4-1.

Figure 4-1. CDPHE Monitoring Station Locations and Sensitive Receptors

Table 4-1. Pollutant Concentrations Measured at Air Quality Monitoring Stations near the Project

Pollutant	Parameter/NAAQS	2018	2019	2020	2021
4201 72nd Avenue in Commerce City (Commerce)					
PM_{10}	Max. 24-hour/150 (µg/m³)	**158**	119	139	NA
$PM_{2.5}$	3-year average of 98th percentile 24-hour/35 (µg/m³)	24	25	26	NA
	Annual average/12 (µg/m³)	10.2	9.0	9.8	NA
7275 Birch Street in Commerce City (Birch)					
PM_{10}	Max. 24-hour/150 (µg/m³)	NA	NA	NA	104
$PM_{2.5}$	98th percentile 24-hour/35 (µg/m³)	NA	NA	NA	29.8
	Annual average/12 (µg/m³)	NA	NA	NA	10.3
3174 East 78th Avenue in Welby (Welby)					
CO	Max. 1-hour/35 (ppm)	2.5	1.8	1.9	2.0
	Max. 8-hour/9 (ppm)	2.1	1.4	1.2	1.5
O_3	3-year average of fourth max. 8-hour/0.070 (ppm)	0.067	0.065	0.069	**0.072**
NO_x	3-year average of 98th percentile 1-hour/100 (ppb)	60	60	60	58
	Annual average/53 (ppb)	15.7	16.6	15.5	15.4
PM_{10}	Max. 24-hour/150 (µg/m³)	106	90	111	96

Source: EPA 2021b and APCD 2022

Note: An exceedance of the NAAQS is shown in **bold** font based on the monitored value for that pollutant and may not represent a violation of the NAAQS depending on the definition of the NAAQS for that pollutant.

NA = not available or the data do not satisfy minimum data completeness criteria

Per the AQ-PLAG, 3 years of data are generally provided, including the average value for 3 years of data for some pollutants that EPA uses for NAAQS determinations, and are the values generally used for NEPA purposes. However, since 2020, pollutant concentrations are no longer monitored at the Commerce City monitoring station. In 2021, the Birch monitoring station was added to monitor PM_{10} and $PM_{2.5}$ concentrations. Therefore, a fourth year was added to Table 4-1 to show the last 3-year design value at the Commerce City monitoring station and the most recent data at the Birch monitoring station. As shown in Table 4-1, there is an exceedance of the 3-year average (2019 to 2021) of the fourth-highest daily maximum ozone concentration of the 8-hour NAAQS. In addition, the maximum 24-hour PM_{10} concentration exceeded the NAAQS once in 2018.

APCD provided the background concentration data from the Commerce City monitoring station for the PM modeling and analysis. The PM concentrations monitored at the Commerce City monitoring station were used for the PM modeling and analysis since it is the most representative for the project area and recorded the highest PM concentrations of PM_{10} in the Denver Metro maintenance area during 2018. Additional information on background concentration data is provided in the PM Work Plan in Appendix G.

4.3 Sensitive Receptors

Children, the elderly, and those with health conditions affected by air pollution are generally considered to be sensitive to air pollutants compared with other individuals. Sensitive air quality receptors generally include receptors such as residences, schools, day care centers, parks and playgrounds, nursing homes, and hospitals. The project is located in an urban area with land uses consisting mostly of industrial uses, along with areas of commercial and residential land uses. The following list includes notable sensitive receptors in the surrounding area, but is not intended to be a comprehensive list:

- Welby Community School
- Assumption Catholic School
- Welby and Other Residents
- C4 Campus
- Alsup Elementary School
- Kids First Health Care
- Adam Heights Residents
- Central Elementary School
- Sanville Preschool
- Suncor Boys and Girls Club
- Veterans Memorial Park
- Adams County School District 14
- Kearney Middle School
- Pioneer Park and Paradice Island Pool
- Monaco Park
- Rose Hill Elementary School
- 14 Stars Early Learning Center
- Victory Preparatory Academy
- Sunshine Head Start
- Leyden Park
- Wetland Park
- Northfield Pond Park

In March and April 2022, online public outreach air quality surveys were conducted for this project to obtain public input on the sensitive receptors selected for the PM modeling. Figure 4-1 depicts the 500-foot buffer for assessing potential MSAT effects as well as other pollutants, the areas of notable sensitive receptors near the 500-foot buffer, and the sensitive receptor locations identified from the public outreach survey. Additional information regarding the sensitive receptor locations identified during the public outreach air quality survey and those modeled for the PM analysis is included in Appendix G. The ambient air concentrations shown in Table 4-1 are similar to the existing conditions experienced by sensitive receptors in the study area.

5.0 Impacts Assessment

This section discusses the potential of the project to affect air quality due to air pollutant emissions from construction and post-construction operation of the study area freeway system.

5.1 Transportation Conformity

The project is located in an area designated as nonattainment for O_3 and maintenance PM_{10} and is federally funded. Therefore, the project would be subject to transportation conformity requirements (40 CFR 93) and needs to demonstrate regional and project-level conformity.

As discussed in Section 4.2.2, as of January 15, 2022, the Denver-Boulder area is in attainment for CO and no longer subject to transportation conformity requirements for CO. In addition, the Denver Metro PM_{10} maintenance area will be in attainment after October 16, 2022, and transportation conformity requirements for PM_{10} will no longer apply.

5.1.1 Regional Conformity

Regional conformity for transportation projects is satisfied by the project's inclusion in a federally approved RTP and regional TIP. DRCOG is the federally designated transportation planning agency for the Denver region, where the study area is located. The DRCOG's 2050 MVRTP (DRCOG 2021) and the 2022-2025 TIP (DRCOG 2020) are the latest federally approved and fiscally constrained conforming plan and program for the DRCOG planning area. The Proposed Action is listed in the 2050 MVRTP, which was adopted by DRCOG in April 2021 and FHWA in June 2021. The conformity determination for CO and PM was last adopted in April 2021. The I-270 Corridor Improvements project is also included in the fiscally constrained 2022-2025 TIP and specifically referenced by TIP number 2020-068.

O_3, CO, and PM_{10} are modeled on a regional basis for the RTP and TIP. The design concept and scope of the project, as described in the EA, is consistent with the project description in the RTP and TIP, and the "open-to-traffic" assumptions in DRCOG's regional emissions analysis. Inclusion in the conforming RTP and TIP demonstrates that the project was evaluated for regional impacts, meets the planning and regional requirements for demonstration of federal conformity, and is consistent with local air quality planning efforts.

5.1.2 Project-level Conformity

A project-level conformity determination is required for projects in nonattainment and maintenance areas. Projects in CO, PM_{10}, and $PM_{2.5}$ nonattainment and maintenance areas need to evaluate whether a hot spot analysis is required.

Section 93.105 of the transportation conformity rule requires IAC with federal, state, and local agencies to make a conformity determination for the project. The initial IAC meeting for the project was held in January 2021 with participants from FHWA, EPA, CDOT, APCD, and Jacobs. Additional meetings were held with the IAC participants to provide additional project information and clarifications. Another IAC meeting was held in April 2022 to discuss updated traffic data from the DRCOG TDM. Appendix B summarizes the IAC and subsequent meetings for conformity requirement determinations.

Carbon Monoxide

The project is in the Denver-Boulder maintenance area for CO. The 20-year maintenance period of the area ended on January 14, 2022. After that date, project-level CO conformity requirements under 40 CFR 93 do not apply pursuant to Section 93.102(b)(4). Nonetheless the CO analysis for this project was included under NEPA to demonstrate that the project would not cause violations of the CO NAAQS and to go above and beyond the C.R.S. 43-1-128 requirements. Section 5.2.4 summarizes the additional analysis and modeling conducted for CO.

Particulate Matter

The project is in the Denver Metro maintenance area for PM_{10} and is subject to project-level conformity requirements. The area will have been in maintenance for 20 years on October 16, 2022, prior to the EA being signed. Therefore, conformity requirements still apply through October 16, 2022. The project's potential to cause localized PM_{10} impacts was evaluated to determine if the project is likely to cause new violations or contribute to existing violations of the PM_{10} standards. The analysis followed the criteria listed in *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in* $PM_{2.5}$ *and* PM_{10} *Nonattainment and Maintenance Areas* (EPA 2021c). According to this guidance, the first step in the PM_{10} hot spot evaluation is to determine whether the project is a POAQC. A project that is not a POAQC is unlikely to cause localized PM_{10} hot spot impacts, thus quantitative modeling is not required to demonstrate conformity.

40 CFR 93.123(b)(1) identifies which types of projects require a quantitative analysis, and these types were used as the criteria to determine whether a project is considered a POAQC:

Criterion #1: New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles

The Proposed Action is to improve the traffic condition by adding one traffic lane per direction to the existing I-270 in the study area. The daily traffic data for total vehicles, total trucks, and total truck percentages on I-270 were derived using the modified DRCOG Focus 2.3 models developed for the project. The daily vehicle volume in the study area under the No Action Alternative is 114,233 to 182,533 on I-270. The Proposed Action would have higher vehicle volume in 2050 compared with the No Action Alternative due to the addition of new travel lanes. Traffic volume of the Proposed Action ranges from 142,807 to 240,486 in 2050, as shown in Table 5-1.

Table 5-1. 2050 Daily Traffic Volume and Diesel Truck Traffic Information

Location	No Action Alternative 2050				Proposed Action 2050					
	Total AADT	Total Trucks	Diesel Truck Percentage	Diesel Trucks	Total AADT	Total Trucks	Diesel Truck Percentage	Diesel Trucks	Truck Increase over No Action Alternative	Diesel Truck Increase over No Action Alternative
Mainline between I-70 and Quebec Street	114,233	9,644	7.3	**8,357**	142,807	10,148	6.1	**8,778**	504	**421**
Mainline between Quebec Street and Vasquez Boulevard	153,413	12,488	7.0	**10,746**	193,775	13,180	5.8	**11,324**	692	**578**
Mainline between Vasquez Boulevard and York Street	181,030	13,611	6.5	**11,691**	240,486	14,318	5.1	**12,271**	707	**580**
Mainline between York Street and I-76	154,537	11,953	6.7	**10,302**	205,264	12,676	5.3	**10,905**	723	**603**
Mainline between I-76 and I-25	182,533	12,323	5.8	**10,616**	222,664	13,059	5.0	**11,230**	736	**614**

Source: DRCOG Model Focus 2.3

Note: the calculated values may differ due to rounding.

I-76 = Interstate 76

Total truck volumes from the DRCOG Focus 2.3 model include medium and heavy trucks. All heavy trucks were assumed to be diesel fueled. In order to determine the number of medium trucks that are diesel, the MOVES defaults were reviewed for single unit short-haul and long-haul trucks (representative of medium trucks), which showed that approximately 60 percent of medium trucks are diesel fueled for model years 1960 to 2060. These results were further refined using the model years specific to the project (2016 to 2050), which showed that approximately 78 percent of the medium trucks would be diesel fueled. Based on this information, the percentage of diesel truck traffic was estimated to be approximately 5.5 percent of the total vehicles on I-270 in the study area. The Proposed Action would not increase the diesel truck percentages on I-270 in the study area. Due to the total traffic volume increase from the Proposed Action, diesel truck volumes on I-270 would increase in the study area. The maximum daily increase of diesel truck volume between the No Action Alternative and Proposed Action ranges from 400 to 600 for all segments.

The diesel truck traffic volume and increases in 2040 for the No Action Alternative and Proposed Action were reviewed during the IAC in January 2021. It was determined that the diesel truck increases due to the Proposed Action would not cause substantial diesel PM emission increase that would cause new violations to the PM_{10} NAAQS. In January 2021, DRCOG released the 2050 TDM and approved it in April 2021. Use of the updated 2050 model was discussed at an IAC follow-up meeting in April 2021, and the decision was made to move forward using the 2050 TDM for the air quality analysis. The 2050 diesel truck traffic volume and increases as presented in Table 5-1 were provided to the IAC participants in April 2022. Although volumes have increased from 2040 to 2050 due to regional growth, the change in daily diesel vehicle volume from the No Action Alternative to the Proposed Action is lower under 2050. Therefore, the previous IAC determination remains valid and the Proposed Action would not significantly increase the diesel truck volume in the study area.

Criterion #2: Projects affecting intersections that are at LOS D, E, or F with a significant number of diesel vehicles, or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project

The Proposed Action would improve the traffic conditions in the study area by providing additional travel lanes on I-270 and improvements to the existing roadways including Vasquez Boulevard, York Street, and 56th Avenue. The improvements would be expected to reduce congestion and idling at intersections and thus increase travel speed. As shown in Attachment 1, Table A-1, of Appendix A, each signalized intersection operates, either now or in the future, with a LOS of D, E, or F. However, the project is not expected to change the vehicle mix at the intersections in the study area or affect intersections that are either now or in the future at LOS D, E, or F with a significant number of diesel vehicles.

Criterion #3: New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location

No new bus or rail terminals would be constructed under the Proposed Action.

Criterion #4: Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location

No bus or rail terminals would be expanded under the Proposed Action.

Criterion #5: Projects in or affecting locations, areas, or categories of sites which are identified in the PM_{10} or $PM_{2.5}$ applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation

The study area was not identified in the region's SIP as a site of possible violation of PM_{10}.

In summary, although the study area is in a maintenance area for PM_{10}, the project would not be a POAQC based on the EPA criteria discussed previously. Therefore, the project is not expected to cause or contribute to new localized PM_{10} violations or increase frequency or severity of existing violations. As such, the project would meet the conformity requirements of 40 CFR 93.116 without a quantitative hot spot analysis. The IAC process was used to review the project information and concur that the project is not a POAQC, thus a detailed quantitative modeling is not required to demonstrate transportation conformity. Appendix B summarizes the IAC and subsequent meetings.

Since the Denver Metro area is in attainment for the $PM_{2.5}$ NAAQS, transportation conformity requirements do not apply and a hot spot analysis for $PM_{2.5}$ is not required.

Although a quantitative PM_{10} and $PM_{2.5}$ hot spot analysis is not required under conformity, CDOT conducted additional analysis under NEPA and went above and beyond to comply with the C.R.S. 43-1-128 requirement that included PM_{10} and $PM_{2.5}$ modeling. Section 5.2 discusses the additional modeling and analysis conducted for PM_{10} and $PM_{2.5}$.

5.2 Other National Environmental Policy Act Considerations

The following sections summarize the air quality analyses conducted in accordance with NEPA, FHWA's MSAT Guidance (FHWA 2016), C.R.S. 43-1-128, and CDOT's AQ-PLAG, Version 1 (CDOT 2019a).

Although the Denver area is attaining the $PM_{2.5}$ NAAQS and dispersion modeling is not required for any pollutants under C.R.S. 43-1-128, CDOT went above and beyond the C.R.S. 43-1-128 requirements and conducted additional modeling and analysis to address any public concerns about air quality in the study area. The purpose of these analyses is to help inform the NEPA process and disclose to the public the anticipated impacts of CO and PM emissions from the project, address public concerns, and provide quantified comparison of impacts among alternatives. Sections 5.2.3 and 5.2.4 summarize the additional analyses and modeling conducted for CO and PM.

5.2.1 Criteria Pollutants Emissions Inventory

In accordance with C.R.S. 43-1-128, an emissions inventory analysis was conducted for transportation-related criteria pollutants: CO, NO_2, PM_{10}, $PM_{2.5}$, and O_3 precursors (NO_x and VOCs). The C.R.S. also requires modeling of MSATs and GHGs. MSATs are discussed in Section 5.2.2. GHGs are discussed in Section 5.2.3. The emission inventory was performed for the roadway network that includes the entire project corridor, the major arterials crossing the project corridor, and local streets near the project corridor that are close to sensitive receptors of concern, as shown on Figure 5-1.

Figure 5-1. Emissions Inventory Area

Source: Jacobs

Emission inventories of criteria pollutants for the existing conditions and in the horizon year of the project were estimated by APCD using EPA's MOVES3 model. The MOVES modeling methodology, included in Attachment 3 of the Air Quality Analysis Work Plan, details the modeling inputs and assumptions for this analysis (Appendix A).

Vehicle emissions were calculated based on the VMT in 2016 for the existing condition, and in 2050 for the No Action Alternative and the Proposed Action. Vehicle exhaust emission factors were modeled by APCD using EPA's MOVES3 model and the project- and region-specific inputs for vehicle fleet mix, speeds, and fuel information. Input parameters for the model are detailed in Attachment 3 of Appendix A. PM_{10} and $PM_{2.5}$ emissions from the project operation include the vehicle engine exhaust, tire wear and brake wear, and re-entrained road dust due to vehicle travel. Re-entrained dust emissions were calculated using PM_{10} and $PM_{2.5}$ emission factors from the latest 2050 MVRTP, Appendix S—Air Quality Conformity Determination Documents, dated April 2021. More detailed information on re-entrained dust is provided in Attachment 3 of Appendix A. Emission inventory data provided by APCD are in Appendix C. Table 5-2 summarizes the daily vehicle emissions for the study area.

Table 5-2. Daily Criteria Pollutant Emissions for the Study Area

Parameter	Existing Conditions 2016	No Action 2050	Proposed Action 2050
VHT/day	36,186	50,649	49,204
VMT/day	1,393,148	1,606,823	1,942,340
CO (tpd)	4.669	1.332	1.329
NO_2 (tpd)	0.097	0.038	0.033
PM_{10} (tpd)	0.247	0.316	0.318
$PM_{2.5}$ (tpd)	0.068	0.075	0.076
NO_x (tpd)	0.742	0.099	0.087
VOC (tpd)	0.104	0.021	0.022

Source: Wells, pers. comm. 2022

tpd = ton(s) per day

As shown in Table 5-2, VMT increases in future years, which is due to economic and population growth. However, emissions of most criteria pollutants decrease from existing conditions to future years, which is due to implementation of stringent emission standards, improvement of fuel efficiency, and vehicle turnovers. PM_{10} and $PM_{2.5}$ emissions slightly increase from existing conditions to future years with approximately 75 to 80 percent of the total PM_{10} and $PM_{2.5}$ emissions attributed to re-entrained road dust. The total emissions from the Proposed Action are slightly lower than the No Action Alternative for most pollutants analyzed, even when the Proposed Action has higher VMT than the No Action Alternative. The decreased emissions from the Proposed Action are attributable to the reduced congestion along the corridor compared with the No Action Alternative, in which congested conditions of lower speeds and idling vehicles result in higher vehicle emissions. The VHT improves, or decreases, under the Proposed Action compared with the No Action Alternative due to added capacity and reduced congestion. In addition, the ramps at the I-270/Vasquez Boulevard interchange would be widened to provide a peak-period queue jump for heavy vehicles to reduce idling time on the ramp while waiting for a green light, thereby reducing emissions.

5.2.2 Mobile Source Air Toxics

Transportation projects may affect the regional or local air toxic concentrations due to the MSAT emissions from vehicles. Potential MSAT effects from the project operation were evaluated following the FHWA memorandum titled *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2016). FHWA developed a tiered approach with three categories for analyzing MSAT impacts, depending on specific project circumstances:

- No analysis for projects with no potential for meaningful MSAT effects

  These projects typically include those qualifying as a categorical exclusion under 23 CFR 771.117; projects exempt under the conformity rule under 40 CFR 93.126; or other projects with no meaningful impacts on traffic volumes or vehicle mix.

- Qualitative analysis for projects with low potential MSAT effects

  According to FHWA's updated interim guidance, projects considered to have low potential MSAT effects include those that improve operations of highway, transit, or freight without adding substantial new capacity or without creating a facility that is likely to meaningfully increase MSAT emissions (FHWA 2016).

- Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects

  Examples of these projects include those that will create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel PM in a single location, involving a significant number of diesel vehicles for new projects or accommodating with a significant increase in the number of diesel vehicles for expansion projects; or create new capacity or add significant capacity to urban highways such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the AADT is projected to be in the range of 140,000 to 150,000 or greater by the design year. These types of projects are also located near populated areas.

Quantitative Analysis of Mobile Source Air Toxics Emissions

The project is located in the populated Denver metropolitan area. Compared with the No Action Alternative, the Proposed Action would increase traffic volumes on I-270 due to the additional travel lanes. All segments on I-270 would exceed 140,000 AADT under the Proposed Action. Therefore, this project would have high potential for MSAT effects, and a quantitative analysis of the MSAT emissions was conducted in accordance with FHWA's MSAT Guidance (FHWA 2016). Emissions of the nine priority MSATs (1,3-butadiene, acetaldehyde, acrolein, benzene, diesel PM, ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter) in the existing conditions and from the No Action Alternative and Proposed Action in 2050 were modeled using the MOVES3 model, and the results are summarized in Table 5-3. The emissions inventory satisfies the MSAT modeling requirements of C.R.S. 43-1-128, as described in Section 5.2.1. Input parameters for the MOVES3 model were the same as those used for the criteria pollutants emission inventory analysis and are detailed in Attachment 3 of the Air Quality Analysis Work Plan (Appendix A). Appendix D provides the complete MSAT discussion.

Table 5-3. Daily MSAT Emissions for the Study Area

Parameter	Existing Conditions 2016	No Action 2050	Proposed Action 2050
VHT/day	36,186	50,649	49,204
VMT/day	1,393,148	1,606,823	1,942,340
1,3-butadiene (ppd)	0.671	0.000	0.000
Acetaldehyde (ppd)	3.009	0.373	0.348
Acrolein (ppd)	0.347	0.027	0.026
Benzene (ppd)	6.297	0.857	0.831
Diesel PM (tpd)	0.011	0.00076	0.00071
Ethylbenzene (ppd)	3.252	0.707	0.672
Formaldehyde (ppd)	5.120	0.464	0.439
Naphthalene (ppd)	0.632	0.033	0.032
Polycyclic Organic Matter (ppd)	0.276	0.0152	0.0149

Source: Wells, pers. comm. 2022

ppd = pound(s) per day

As shown in Table 5-3, the VMT estimated for the Proposed Action is higher than that for the No Action Alternative, because the project would add new travel lanes that attract additional trips that would not otherwise occur in the study area. Although there is an increase in VMT, MSATs under the Proposed Action would be lower than the No Action Alternative in the study area. In addition, further decreases in MSAT emissions in the study area are likely due to emissions reductions from reduced congestion and increased vehicle speeds. Also, MSAT emissions would be lower in other locations when traffic shifts from existing roadways to the improved I-270.

5.2.3 Greenhouse Gases

Currently, there are no federal approved policies or guidance to assist with the evaluation of GHGs impacts for transportation projects. Per the AQ-PLAG, GHG analysis is qualitative and not project specific for EAs. The GHG analysis for the project used the GHG template language contained in Appendix F of CDOT's *NEPA Manual* (2019b). GHGs emissions were also modeled to meet the requirements of C.R.S. 43-1-128. The GHG analysis included quantifying CO_2, CH_4, and N_2O emissions from on-road vehicles in the study area using MOVES3, as described in Section 5.2.1. Appendix E provides the complete GHG discussion.

EPA's MOVES3 model was used to estimate vehicle exhaust emissions of CO_2 and other GHGs. CO_2 is frequently used as an indicator of overall transportation GHG emissions because the quantity of these emissions is much larger than that of all other transportation GHGs combined, and because CO_2 accounts for 90 to 95 percent of the overall climate impact from transportation sources.

The MOVES3 model was run to estimate GHG emissions in the study area with the No Action Alternative and Proposed Action. Input parameters for the model were the same as those used for other MOVES3 analyses and are detailed in Attachment 3 of the Air Quality Analysis Work Plan (Appendix A). Table 5-4 shows the GHG emissions associated with the project. Total emissions of GHG are presented as CO_2 equivalent (CO_2e) that were calculated using the global warming potential of each GHG.

Table 5-4. Emissions of Greenhouse Gases in the I-270 Corridor Improvements Study Area in 2050

Greenhouse Gas	Existing Conditions Emissions (tpy) 2016	No Action Alternative Emissions (tpy) 2050	Proposed Action Emissions (tpy) 2050	Percent Change from Proposed Action and No Action Alternatives
CH_4	7.145	3.879	3.546	-8.58
N_2O	1.140	0.580	0.533	-8.10
Atmospheric CO_2	160,804	136,933	137,823	+0.65
Total CO_2e	**161,320**	**137,201**	**138,070**	**+0.63**

Source: Wells, pers. comm. 2022

CO_2e = CO_2 equivalent, calculated using the global warming potential of 298 for N_2O and 25 for CH_4 in MOVES3

tpy = ton(s) per year

As shown in Table 5-4, total GHG emissions would decrease in 2050 compared with the existing condition for both the No Action Alternative and Proposed Action due to improvements in vehicle emission rates, even with increased VMT in 2050. Modeled GHG emissions for the 2050 Proposed Action are slightly (less than 1 percent) higher compared with the No Action Alternative due to a combination of the effects from the increased VMT, reduced congestion, and improved vehicle economy.

5.2.4 Additional Air Pollutant Analyses

Carbon Monoxide Analysis

Although the project is no longer subject to conformity requirements for CO, the CO analysis was completed when conformity was still required in the maintenance area. In addition, although dispersion modeling is not required under C.R.S. 43-1-128 requirements, CDOT conducted this additional analysis to help inform the NEPA process and address any public concerns, especially in environmental justice communities. The CO analysis was conducted to evaluate whether the project would cause localized increases of CO concentrations that would violate NAAQS at congested intersections. The CO analysis was performed following the guidelines in CDOT's AQ-PLAG (CDOT 2019a) and EPA's *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (EPA 1992).

The LOS during morning (a.m.) and afternoon (p.m.) peak hours in 2050 was reviewed for signalized intersections affected by the Proposed Action. Table D-1 in Appendix F summarizes all signalized intersections and traffic data under existing and 2050 conditions for the Proposed Action and the No Action Alternative. Intersections with an LOS of A, B, or C were considered to have insubstantial impacts on air quality, and no further analysis was needed per EPA guidelines. The guidelines recommend screening the three intersections with the worst LOS or highest delay and the three intersections with the highest traffic volumes. Among these intersections, the intersection at Vasquez Boulevard and East 56th Avenue under the Proposed Action has both the highest traffic volume and delay. Therefore, the intersection at Vasquez Boulevard and East 56th Avenue was considered to represent a worst-case operation scenario of the Proposed Action and was selected for further analysis. Because the CO analysis was conducted when conformity still applied to the Denver-Boulder maintenance area, the decision to model a worst-case intersection instead of multiple intersections was agreed upon during IAC meetings and subsequent meetings, as documented in Appendix B.

Quantitative CO modeling was performed using the MOVES3 and CAL3QHC models for the Proposed Action for the year 2050. The CO analysis followed the guidance in *Using MOVES3 in Project-Level Carbon Monoxide Analyses* (EPA 2021d) and *Guideline for Modeling Carbon Monoxide from Roadway Intersections* (EPA 1992). The modeling results were compared with the CO NAAQS to determine whether localized increases would occur that would violate the NAAQS.

Vehicular CO emissions were modeled by APCD using emission factors from EPA's MOVES3 model and region-specific inputs. Emission factors were obtained for both free-flow speeds and periods of idle for the existing year of 2016 and horizon year of 2050. Free-flow speeds were selected based on posted speed limits of the roadways of the intersection evaluated and ranged from 30 to 45 miles per hour (mph). A speed of 0 mph was used to calculate an idle emission factor. The motor vehicle emission factors of the existing year (2016) and the peak hour traffic volumes of the horizon year (2050) were used in the modeling to represent a worst-case emission scenario of the project (CDOT 2019a).

The CO modeling used the CAL3QHC dispersion model to estimate the maximum 1-hour CO concentrations near the affected intersection. Eight-hour CO concentrations were obtained by multiplying the maximum 1-hour CO concentrations by a region-specific persistence factor of 0.649, which was provided by APCD. The persistence factor accounts for the fact that over 8 hours (as distinct from a single hour), vehicle volumes would fluctuate downward from the peak hour, vehicle speeds may vary, and meteorological conditions, including wind speed and wind direction, would vary compared with the conservative assumptions used for the single hour.

Receptors were placed around the intersections at distances of 0, 25, and 50 meters along each approach. The receptors were placed 3 meters from the edge of the street to ensure that they were not within the mixing zone of the travel lanes (EPA 1992). Table 5-5 summarizes the input values used in CAL3QHC modeling. Appendix F includes the CAL3QHC model input and output files.

Table 5-5. CO Modeling Parameters

Parameter	Value [a]
Surface Roughness	127 cm
Wind Speed	1 m/s
Stability Class	E
Mixing Height	1,000 m
Wind Direction Increment	10 degrees
Receptor Height	1.8 m
Source Height	0 m
Signal Type	Actuated
Intersection Arrival Rate	Average progression

[a] Parameter values are from EPA 1992.

cm = centimeter(s)
m = meter(s)
m/s = meter(s) per second

Background concentrations of CO used in the analysis were the maximum CO concentrations monitored in 2016 of the study area provided by APCD; these concentrations were added to the modeling results to determine the maximum predicted concentration due to the worst-case intersection operation. The maximum CO concentrations as shown in Table 5-6 demonstrated that the worst-case intersections in the study area would not cause exceedances of the 1-hour or 8-hour CO NAAQS. All other intersections within the study area would have lower CO concentrations than the worst-case intersection. Therefore, the project would not cause new violations of the NAAQS for CO at affected intersections within the study area. Predicted 1-hour and 8-hour maximum CO concentrations are shown in Table 5-6.

Table 5-6. Maximum Predicted Concentrations for the Worst-case Intersection of the Proposed Action

Intersection	2050 1-hour (ppm)	2050 8-hour (ppm)
Vasquez Boulevard and East 56th Avenue	6.65 (compare to NAAQS of 35 ppm)	4.32 (compare to NAAQS of 9 ppm)

Source: Jacobs

Note: The results presented in the table include the maximum 1-hour and 8-hour background concentrations of 5.249 ppm and 3.404 ppm, respectively, which are the maximum concentrations in existing year 2016. Background concentrations were obtained from APCD.

Particulate Matter Modeling and Analysis

The EPA-recommended air quality dispersion model (AERMOD) was used to assess potential impacts of PM_{10} and $PM_{2.5}$ emissions from vehicle travel in the study area, including environmental justice communities and other sensitive receptors in the near-road areas along the I-270 corridor. The purpose of this additional expanded analysis is to help inform the NEPA process and go above and beyond the C.R.S. 43-1-128 requirements to disclose to the public the anticipated impacts of PM emissions in the study area, address public concerns, and provide quantified comparison of impacts between among alternatives. The PM modeling analysis for the Proposed Action resulted in 24-hr average PM_{10}, 24-hr average $PM_{2.5}$, and annual average $PM_{2.5}$ design concentrations that are less than or equal to the relevant NAAQS at all modeled receptors. Based on those results, the Proposed Action would not cause or contribute to new violations of the PM NAAQS. More detailed information on this PM modeling analysis is provided in a separate PM Technical Report in Appendix H.

5.2.5 Construction Emissions

Project construction would result in short-term, temporary emissions of fugitive dust and equipment-related exhaust emissions such as NO_x, CO, VOCs, and PM (PM_{10} and $PM_{2.5}$) in the study area. Construction of the project is not expected to last longer than 5 years. Therefore, construction emissions do not need to be accounted for in a hot spot analysis per 40 CFR 93.123(c)(5).

Sources of fugitive dust (PM_{10} and $PM_{2.5}$) during project construction would include disturbed surface areas at the construction site and trucks carrying uncovered loads of soil/debris. Fugitive dust emissions would vary from day to day, depending on the nature and magnitude of construction activity and local weather conditions. Dust emissions would depend on conditions such as soil moisture, silt content of soil, wind speed, and the number of construction vehicles operating.

Exhaust emissions during construction would be generated by fuel combustion in motor vehicles and construction equipment. Construction vehicles and disruption of normal traffic flow could result in increased motor vehicle emissions in certain areas. These emissions would be temporary and limited to the immediate area surrounding the construction site. Details of the emission control measures are discussed in Section 6.0. The project construction would comply with CDOT *Standard Specifications for Road and Bridge Construction* (CDOT 2021).

6.0 Avoidance and Minimization Measures

Based on the analysis discussed previously, the project is not expected to:

- Cause or contribute to any new localized CO and $PM_{10}/PM_{2.5}$ violations
- Increase the frequency or severity of any existing CO and $PM_{10}/PM_{2.5}$ violations
- Delay timely attainment of any NAAQS or any required interim emission reductions, or other milestones in CO and $PM_{10}/PM_{2.5}$ nonattainment and maintenance areas

The project meets regional and project-level conformity requirements. Additional PM_{10} and $PM_{2.5}$ analysis demonstrated that the project would not cause violations to the NAAQS. Therefore, the project is not anticipated to cause substantial adverse effects on air quality in the future condition.

However, compared with the No Action Alternative, an increase in some pollutant emissions (associated with increases in VMT) is anticipated with the Proposed Action. Several strategies have been and continue to be implemented in the DM/NFR to reduce ozone precursor emissions of VOCs and NO_x, including multimodal transportation options, rideshare programs, and vehicle inspection and maintenance programs. In additional, several strategies have been and continue to be implemented to maintain attainment of CO and PM_{10} NAAQS. Section 6.1 also describes measures to reduce GHGs, which would also reduce other pollutants.

As stated in Section 5.2.5, the proposed project would result in temporary construction emissions. Section 6.2 summarizes the temporary effects and measures that would be implemented during construction to help minimize any increases in pollutant emissions.

6.1 Greenhouse Gases

To help address the global issue of climate change, USDOT is committed to reducing GHG emissions from vehicles traveling on highways. USDOT and EPA are working together to reduce these emissions by substantially improving vehicle efficiency standards and moving toward less-carbon-intensive fuels. The agencies have jointly established new, more-stringent fuel economy standards and the first-ever GHG emissions standards for cars and light trucks, which were revised in 2021 for model years 2017 to 2026, with an ultimate real-world fuel economy goal of 40 miles per gallon for cars and light trucks by model year 2026. In addition, on September 15, 2011, the agencies jointly published the first-ever (Phase 1) fuel economy and GHG emissions standards for heavy-duty trucks and buses. In October 2016, the agencies finalized Phase 2 standards for medium- and heavy-duty vehicles through model year 2027. Also, increasing use of technological innovations that can improve fuel economy, such as gasoline- and diesel-electric hybrid vehicles, will improve air quality and reduce CO_2 emissions in future years.

The construction best practices described in Section 6.2 are practicable project-level measures that could help reduce GHG emissions incrementally and could contribute in the long term to meaningful cumulative reduction when considered across the Federal-Aid Highway Program.

At the state level, planning activities are key to reducing GHGs from highway projects and mitigating GHGs. To this end, Colorado has developed legislation, regulation, and policies and programs, as listed in Section 2.2.3, to address transportation GHGs and to prepare infrastructure in the state for current and future impacts of climate change.

6.2 Construction Emissions

Temporary effects to the local air quality are anticipated during construction because the proposed project would likely have localized diesel-emitting sources from construction equipment and vehicles traveling to and from the construction site. Therefore, the proposed project will comply with CDOT *Standard Specifications for Road and Bridge Construction* (CDOT 2021), AQCC Regulation 1 (5 CCR 1001-3, Emission Control for Particulate Matter, Smoke, Carbon Monoxide, and Sulfur Oxides), and Regulation 3 (5 CCR 1001-5, Stationary Source Permitting and Air Pollutant Emission Notice Requirements) to ensure that appropriate control measures are implemented during construction to reduce emissions of most pollutants and control fugitive dust.

Typical emission and dust control measures include, but are not limited to, the following:

- Cover, wet, compact, or use chemical stabilization binding agent to control dust and excavated materials at construction sites.
- Use wind barriers and wind screens to prevent spreading of dust from the site.
- Have a wheel wash station and/or crushed stone apron at egress/ingress areas to prevent dirt from being tracked onto public streets.
- Use vacuum-powered street sweepers to remove dirt tracked onto public streets.

- Cover all dump trucks that are hauling material leaving sites to prevent dirt from spilling onto public streets.
- Minimize disturbed areas—particularly in winter.
- Prohibit unnecessary idling of construction equipment.
- Locate construction diesel engines as far away as possible from residential areas.
- Locate staging areas as far away as possible from residential areas.
- To the extent practical, use heavy construction equipment that has the cleanest available engines or that can be retrofitted with diesel particulate-control technology.
- To the extent practical, use alternatives to diesel engines and/or diesel fuels, such as biodiesel, liquefied natural gas, or compressed natural gas, fuel cells, and electric engines.
- Install engine pre-heater devices to eliminate unnecessary idling for wintertime construction.
- Prohibit tampering with equipment to increase horsepower or to defeat an emission control device's effectiveness.
- Require construction vehicle engines to be properly tuned and maintained.
- Use construction vehicles and equipment with the minimum practical engine size for the intended job.

The contractor will be required to follow the requirements of filing an Air Pollutant Emission Notice(s) (APEN) for the project. APENs are submitted to CDPHE and used to report predicted emissions, apply for a permit, and modify an existing permit. The proposed project may need to obtain a permit if predicted emissions are greater than permit thresholds as defined by CDPHE. Preparation of a fugitive dust control plan will also be required to specify measures to reduce dust emissions during construction. The contractor will also be required to obtain any air quality permits for stationary sources unless exempt.

Monitoring was conducted prior to construction to comply with the requirements of C.R.S. 43-1-128 as discussed in Section 2.2.2. During construction, the contractor will comply with the requirements of C.R.S. 43-1-128. This includes requirements to develop and implement a PM construction plan to monitor and report concentrations to the public, provide alerts to the public when exceedances occur, prepare action plans to prevent emission exceedances, and develop and implement a plan to mitigate air quality impacts on communities. The C.R.S. 43-1-128 requirement will be met by the parallel air quality research project, as described in Section 2.2.2, that will conduct monitoring during construction and provide a dashboard for community education and awareness.

Table 6-1 lists the emission control measure commitments for the project.

Table 6-1. Emission Control Measure Commitments

Activity Triggering Mitigation	Location of Activity	Impact	Emission Control Measure Commitment	Responsible Branch	Timing/Phase That Mitigation Will Be Implemented
Construction	Study area	Release of fugitive dust emissions from the construction activities	Prepare a Fugitive Dust Control Plan to specify measures to reduce dust during construction.	CDOT Engineering and Contractor	Pre-construction
Construction	Study area	Release of diesel emissions from construction equipment and fugitive dust from construction activities	Implement control measures as described in Section 6.1 to reduce exhaust.	CDOT Engineering and Contractor	During construction
Construction	Study area	Increase of PM_{10} and $PM_{2.5}$ emissions	Develop and implement construction plans for PM_{10} and $PM_{2.5}$ per C.R.S. 43-1-128.	CDOT Engineering and Contractor	Pre-construction and during construction

7.0 Cumulative and Indirect Effects

A qualitative assessment of cumulative and indirect effects was conducted for this project. The results are summarized in the *Cumulative and Indirect Effects Technical Report,* Appendix A of the EA. Assessments of cumulative impacts and indirect effects can be conducted as part of the transportation planning process under FHWA and the Federal Transit Administration's transportation planning regulations (23 CFR 450 Appendix A) and under 23 *United States Code* 168. Therefore, cumulative impacts and indirect effects of the Proposed Action, except the No Action Alternative, are accounted for cumulatively in the DRCOG's 2050 MVRTP (DRCOG 2021) and the 2022-2025 TIP (DRCOG 2020), and specifically referenced by TIP number 2020-068.

8.0 Required Notices and Permits

The following notices and permits related to air quality and/or actions may be required as part of the proposed project:

- Air Pollutant Emission Notice(s) (APEN)

9.0 References

Colorado Department of Public Health and Environment Air Pollution Control Division (APCD). 2022. *Ambient Air Monitoring Network Plans*. https://www.colorado.gov/airquality/tech_doc_repository.aspx.

Colorado Department of Transportation (CDOT). 2019a. *Air Quality Project-Level Analysis Guidance*. February. https://www.codot.gov/programs/environmental/air-quality/assets/cdot-aq-plag.

Colorado Department of Transportation (CDOT). 2019b. *Update to CDOT NEPA Manual, Appendix F – Standard Language (Global Climate Change Cumulative Effects Standard Language).* February 14. https://www.codot.gov/programs/environmental/air-quality/assets/cdot-nepa-manual-app-f-ghg-update-021419-1.

Colorado Department of Transportation (CDOT). 2021. *Standard Specifications for Road and Bridge Construction*. https://www.codot.gov/business/designsupport/cdot-construction-specifications.

Denver Regional Council of Governments (DRCOG). 2020. *2022-2025 Transportation Improvement Program*.

Denver Regional Council of Governments (DRCOG). 2021. *2050 Metro Vision Regional Transportation Plan.*

Federal Highway Administration (FHWA). 2016. *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*. October 18. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/.

National Weather Service (NWS). 2021. Weather.gov. https://www.weather.gov/.

Polis, Jared. 2021. *Colorado Greenhouse Gas Pollution Reduction Roadmap*. January 14. https://energyoffice.colorado.gov/climate-energy/ghg-pollution-reduction-roadmap.

Regional Air Quality Council (RAQC). 2021a. "Ozone (2008 8-Hour Standard)." https://raqc.org/sip/ozone-2008-8-hour-standard/.

Regional Air Quality Council (RAQC). 2021b. "Ozone (2015 8-Hour Standard)." https://raqc.org/sip/ozone-2015-8-hour-standard/.

U.S. Environmental Protection Agency (EPA). 1992. *Guideline for Modeling Carbon Monoxide from Roadway Intersections*. November. https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses#coguidance.

U.S. Environmental Protection Agency (EPA). 2014. *National Air Toxics Assessment.* https://www.epa.gov/national-air-toxics-assessment.

U.S. Environmental Protection Agency (EPA). 2020. "NAAQS Table." https://www.epa.gov/criteria-air-pollutants/naaqs-table.

U.S. Environmental Protection Agency (EPA). 2021a. "Integrated Risk Information System." https://www.epa.gov/iris.

U.S. Environmental Protection Agency (EPA). 2021b. "Monitor Values Report." https://www.epa.gov/outdoor-air-quality-data/monitor-values-report.

U.S. Environmental Protection Agency (EPA). 2021c. *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in* $PM_{2.5}$ *and* PM_{10} *Nonattainment and Maintenance Areas*.

U.S. Environmental Protection Agency (EPA). 2021d. *Using MOVES2014 in Project-Level Carbon Monoxide Analyses.* December.

Wells, Dale, APCD. 2022. Personal communication (email) with Dana Ragusa, Jacobs. February 15.

Appendix A
Air Quality Analysis Work Plan

Air Quality Analysis Work Plan

I-270 Corridor Improvements

January 14, 2022

1.0 Introduction

The Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA), in conjunction with local partners Adams County and Commerce City, are proposing improvements to approximately 6.5 miles of Interstate 270 (I-270) in Adams County, Commerce City, and the City and County of Denver, Colorado, between Interstate 25 (I-25) and Interstate 70 (I-70).

This air quality analysis work plan outlines the purpose and methodology for the carbon monoxide (CO) hot spot analysis, mobile source air toxics (MSATs) analysis, greenhouse gases (GHGs) analysis, and emissions inventory for the I-270 Corridor Improvements project. CDOT is analyzing particulate matter (PM) with diameter equal to or less than 2.5 micrometers ($PM_{2.5}$) and PM with diameter equal to or less than 10 micrometers (PM_{10}) and preparing a separate work plan for that analysis.

2.0 Project Description

The I-270 Corridor Improvements project would modernize the I-270 corridor and address its safety, reliability, and freight movement needs through a combination of roadway infrastructure and technology improvements. Along the 6.5-mile corridor extending from the I-270/I-25/U.S. Highway 36 interchange to the I-270/I-70 interchange, the Proposed Action would reconstruct and widen the I-270 mainline in both directions to accommodate one additional travel lane in each direction, full-width (10-foot or greater) shoulders, and a 4-foot buffer for an express lane operating option. Twelve-foot-wide auxiliary lanes may also be placed in between interchanges to help accelerating and decelerating traffic. The existing grassy median, which varies from 5 to 25 feet where present, would be graded and paved to accommodate the roadway widening. Widening to the outside of the existing pavement edge would also be needed in some areas, requiring minor amounts of right-of-way for construction and operation of the improved interstate. Most of the I-270 bridge structures would be replaced with new bridges to meet vertical clearance requirements. The structures not being replaced have been constructed as more recent improvements to I-270 and are still within their expected service life.

The four interchanges within the corridor (not including the I-270 interchange with I-25 and I-70) would be modernized through construction of new on- and off-ramps that would increase the acceleration and deceleration lengths, increase turning radius and superelevation, and reduce the number of weave points between interstate traffic and local traffic accessing I-270. Auxiliary lanes between the interchanges would further reduce weaving by separating interstate traffic from local traffic and providing more time for heavy trucks to accelerate to interstate speed before merging. The full cloverleaf interchange at I-270/Vasquez Boulevard would be replaced with a partial cloverleaf interchange design that improves safety and connectivity with the local roadway network.

The project would also improve multimodal travel and the local roadway network at York Street, East 56th Avenue, and potentially Holly Street. Where it ties into the I-270 eastbound on-ramp, York Street would be widened to accommodate an expanded roadway template, including additional travel lanes and a multi-use trail, as identified in the Adams County York Street Phase III project. In addition, East 56th Avenue would be improved via widening, curve flattening, and sidewalk extension.

To facilitate drainage of the widened interstate and protect the adjacent watercourses, the project would include permanent water quality features such as sediment vaults, drop inlets, outfalls, and water quality ponds. Intelligent transportation system infrastructure would be installed to provide driver information and equip the roadway to leverage current and future technology, such as variable message signs that provide drivers with accident and roadway condition information. The Proposed Action also includes tolling-related technology and signage.

3.0 Purpose of the Air Quality Analysis

The purpose of the air quality analysis is to analyze impacts associated with the project through an Environmental Assessment (EA) process in accordance with the National Environmental Policy Act (NEPA) and applicable air quality requirements, including the U.S. Environmental Protection Agency (EPA) transportation conformity rule, the FHWA MSAT guidance, and Colorado Revised Statute (CRS) 43-1-128.

4.0 Methodology

The air quality analysis will be completed based on the requirements of NEPA, the conformity provisions of the Clean Air Act Amendments, the FHWA *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (2016), CRS 43-1-128, and the CDOT *Air Quality Project-Level Analysis Guidance* (AQ-PLAG), Version 1 (CDOT 2019a). The analysis will be performed for existing conditions (2016) and for the No Action Alternative and Proposed Action for the horizon year of 2050. An Air Quality Technical Report will be prepared, and the analysis will be incorporated into the NEPA document. If required, mitigation measures will be identified. The following sections provide additional details on the methodology and assumptions for the air quality analysis.

4.1 Transportation Conformity

Per 40 *Code of Federal Regulations* (CFR) 93.102, the project would be subject to transportation conformity requirements because it is federally funded and is located in a nonattainment area for ozone and maintenance areas for CO and PM_{10}. Regional conformity of the project has been demonstrated by the Denver Regional Council of Governments. This will be shown as part of the project-level conformity analysis by confirming that the project is included in and the project design concept and scope of the project are consistent with the latest conforming Denver Regional Council of Governments' Regional Transportation Plan and Transportation Improvement Program.

Project-level conformity will also be evaluated for CO and PM_{10} as described in Sections 4.3 and 5.3 of the AQ-PLAG (CDOT 2019a) to demonstrate that the project would not do the following:

- Cause or contribute to any new localized CO and PM_{10} violations
- Increase the frequency or severity of any existing CO and PM_{10} violations
- Delay timely attainment of any national ambient air quality standards (NAAQS) or any required interim emission reductions, or other milestones in CO and PM_{10} nonattainment and maintenance areas

Methodologies of CO and PM_{10} project-level analyses are discussed in the following sections.

4.1.1 Carbon Monoxide Project-level Analysis

A quantitative CO hot spot analysis will be conducted because the proposed project would affect intersections with current level of service (LOS) D, E, or F, and intersections that will change to LOS D, E, or F because of increased traffic volumes related to the project, as discussed in this section.

CO hot spot analysis will be performed in accordance with the EPA *Guideline for Modeling Carbon Monoxide From Roadway Intersections* (1992). Signalized intersections that are anticipated to operate at

LOS D or worse within the study area were screened to identify the top three intersections with the worst LOS/highest delay and the top three intersections with the highest traffic volumes, as prescribed by Chapter 3 of the EPA guidance (1992). Attachment 1, Table 1, summarizes all signalized intersections under existing and horizon year conditions for the Proposed Action as well as the No Action Alternative. Based on this intersection data, only five intersections meet the EPA screening criteria of having a LOS of D, E, or F in the existing year and/or horizon year. However, because Colorado has not had an exceedance of the CO NAAQS since 1996, it was discussed via interagency consultation that the screening procedure could be refined to only model the worst operating intersection with the highest delay and the intersection with the highest traffic volumes. The intersection of Vasquez Boulevard and East 56th Avenue meets both criteria and will be the only intersection to be modeled in the quantitative CO hot spot analysis. Attachment 2 details the methodology of the traffic analysis conducted to support this air quality analysis.

Per EPA guidance, the CAL3QHC air quality dispersion model will be used for the quantitative analysis. The modeling will follow the guidance titled *Using MOVES2014 in Project-Level Carbon Monoxide Analyses* (EPA 2015) and the *Guideline for Modeling Carbon Monoxide From Roadway Intersections* (EPA 1992). However, the Motor Vehicle Emissions Simulator model MOVES3 will be used instead of MOVES2014 because this newer version is available for use during EPA's 2-year grace period and provides more up-to-date default parameters. Inputs to the CAL3QHC model will include a meteorological condition of 1 meter per second wind speed, 1,000 meters of mixing height, and a stability class E. The surface roughness will be based on the land use surrounding the modeled intersection. Land uses in this area consist of several low-level industrial buildings, and the rest are recreational. Surface roughness of 127 centimeters, which represents the roughness of parks, will be used for the analysis. Wind directions will be evaluated in 10-degree increments. Receptors will be placed around the intersections because maximum emissions occur while vehicles are stopped and idling at traffic signals. Concentrations will be calculated at a receptor height of 1.8 meters, or 5.9 feet.

Coordination was conducted with the Colorado Department of Public Health and Environment's Air Pollution Control Division (APCD) to obtain vehicles' CO emission factors from the MOVES model for input into the dispersion model (CAL3QHC). APCD will also provide 1-hour and 8-hour CO background concentrations and 8-hour CO persistence factors. Per the AQ-PLAG (CDOT 2019a), CO hot spot modeling will be conducted based on present-day motor vehicle emission factors and future peak-hour traffic volumes.

The output from the CAL3QHC model will be expressed as the maximum 1-hour concentrations of CO in terms of parts per million. The maximum hourly concentrations will be converted to an 8-hour average for comparison with the 8-hour NAAQS using a persistence factor obtained from APCD.

4.1.2 Particulate Matter Project-Level Analysis

The following guidance was used to determine the level of analysis required for PM_{10}: EPA *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (2021), updated guidance under EPA's *PM Hot-spot Analyses: Frequently Asked Questions* (2018), and CDOT's AQ-PLAG (2019a).

Quantitative PM_{10} hot spot modeling is required for the following types of projects as defined in 40 CFR 93.123(b)(1):

- New highway projects that have a significant number of diesel vehicles, and expanded highway projects that have a significant increase in the number of diesel vehicles
- Projects affecting intersections that are at LOS D, E, and F with a significant number of diesel vehicles, or those that will change to LOS D, E, or F because of increased traffic volumes from a significant number of diesel vehicles related to the project

- New bus and rail terminals and transfer points that have a significant number of diesel vehicles congregating at a single location
- Expanded bus and rail terminals and transfer points that significantly increase the number of diesel vehicles congregating at a single location
- Projects in or affecting locations, areas, or categories of sites that are identified in the $PM_{2.5}$ or PM_{10} applicable implementation plan or implementation plan submission, as appropriate, as sites of violation or possible violation

The transportation conformity rule (40 CFR 93) does not define "significant"; it is based on the project of air quality concern (POAQC) definition, which is based on either the volume of diesel trucks or the type of project. Appendix B of EPA's *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (2021) provides example projects that would be considered POAQCs. These example projects are listed as follows, along with notes in italics on I-270's potential applicability:

- Projects on a new highway that serve a significant volume of diesel vehicle traffic (such as for new highways, greater than 125,000 annual average daily traffic [AADT] and 8 percent diesel trucks, which is 10,000 trucks per day). *(I-270 is not a new highway. Projected 2050 AADT and truck percentages/volumes are presented in Attachment 1, Table 2.)* Expansion of an existing highway or facility that affects an intersection operated at LOS D, E, or F that has a significant increase in the number of diesel trucks. *(The project will affect intersections with LOS D or worse conditions, but it would not significantly increase the number of diesel trucks as shown in the last bullet of this section.)*
- New exit ramps or other highway facility improvements to connect a highway to a major freight, bus, or intermodal terminal. *(No connections to any such terminals are planned.)*
- Similar highway projects that involve a significant increase in the number of diesel transit buses or diesel trucks. *(The overall diesel truck percentage was estimated based on MOVES default data for medium trucks and assuming all heavy trucks are diesel. MOVES default data for single unit short haul and long haul categories 52 and 53 (representative of medium trucks) shows approximately 60 percent of medium trucks are diesel for model years 1960 to 2060. These results were further refined using the model years specific to our project (2016 to 2050) resulting in approximately 78 percent of the medium trucks would be diesel. The percent increase from 60% to 78% is because majority of the vehicles prior to approximately 1987 (according to MOVES) were gasoline powered. Based on 2050 horizon traffic data, the overall diesel truck percentage averages to approximately 5.5 percent of the total vehicles. This is conservative and higher than the regional diesel truck percentage of 4.29 percent used for the state implementation plan modeling. The increase in diesel trucks between the No Action Alternative and Proposed Action ranges from approximately 400 to 600 diesel trucks per day. Attachment 1, Table 2 summarizes the 2050 traffic data.)*

In addition, Appendix B of the EPA guidance also provides examples of projects that are not projects of air quality concern that apply to I-270:

- Any new or expanded highway project that primarily services gasoline vehicle traffic (that is, does not involve a significant number or increase in the number of diesel vehicles), including such projects involving congested intersections operating at LOS D, E, or F

Based on the traffic data presented in Attachment 1, Table 2, FHWA, in consultation with CDOT, EPA, and APCD, determined that the project is not a POAQC.

4.2 National Environmental Policy Act Considerations

The I-270 EA will document the project's compliance with the conformity requirements discussed previously and the air quality analysis conducted to support the EA process and decision-making under NEPA as outlined in the AQ-PLAG (CDOT 2019a) and in accordance with all federal and state rules and regulations, including CRS 43-1-128.

4.2.1 Criteria Pollutant Analysis

CDOT will conduct a criteria pollutant emission analysis in accordance with CRS 43-1-128. This is a new CRS, which went into effect in June 2021. Before that, a criteria pollutant analysis was going to be done under Section 7 of the AQ-PLAG (CDOT 2019a). The purpose of the analysis is to provide additional information regarding the relative emission levels of the existing conditions, No Action Alternative, and Proposed Action. This analysis will include a summary of the emissions of transportation-related criteria pollutants including CO, nitrogen dioxide, PM_{10}, $PM_{2.5}$ and ozone precursors (nitrogen oxides and volatile organic compounds). CDOT will coordinate with APCD to obtain emission factors and/or pollutant burdens from the MOVES model. Attachment 3 summarizes the MOVES inputs and assumptions used to model the emissions inventory of all pollutants listed previously.

In addition, the air quality dispersion model AERMOD will be used to assess potential impacts of PM_{10} and $PM_{2.5}$ emissions from vehicle travel in the study area. The purpose of this expanded analysis is to help inform the NEPA process and disclose to the public the anticipated impacts of PM emissions in the study area, address public concerns, and provide quantified comparison of impacts between alternatives. CDOT will prepare a separate work plan for this PM analysis detailing the approach and methodology of the modeling and analysis. CDOT will coordinate with APCD to obtain PM background concentrations, meteorological data, and persistence factors.

4.2.2 Mobile Source Air Toxics Analysis

The FHWA *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (2016) will be followed to analyze MSATs. The guidance document outlines a tiered approach as follows:

1. *No analysis for projects with no potential for meaningful MSAT effects*

   Projects of this level are those qualifying as a categorical exclusion under 23 CFR 777.117(c), or exempt under the Clean Air Act conformity rule under 40 CFR 93.126, or with no meaningful impact on traffic volumes or vehicle mix.

2. *Qualitative analysis for projects with low potential MSAT effects*

   Projects at this level include those that serve to improve operations of highway, transit, or freight without adding substantial new capacity or without creating a facility that is likely to meaningfully increase MSAT emissions. Examples are minor widening projects, new interchanges, replacing a signalized intersection on a surface street, and projects in which design-year traffic is projected to be less than 140,000 to 150,000 AADT.

3. *Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects*

   Projects at this level are those with the potential for meaningful differences among project alternatives. FHWA requires a quantitative analysis for highway projects that are proposed to be in proximity to populated areas and meet the following criteria:

   - Create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel PM in a single location, involving a significant number of diesel vehicles for new projects or accommodating with a significant increase in the number of diesel vehicles for expansion projects

- Create new capacity or add significant capacity to urban highways such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the AADT is projected to be in the range of 140,000 to 150,000, or greater, by the design year

The project is located in the populated Denver metropolitan area. As shown in Attachment 1, Table 2, the Proposed Action would exceed 140,000 AADT along all segments. Therefore, a quantitative MSAT emission analysis will be conducted, which will include an emissions inventory of the nine priority MSATs (1,3-butadiene, acetaldehyde, acrolein, benzene, diesel PM, ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter). The emissions inventory would also partially satisfy the requirements of CRS 43-1-128. CDOT will coordinate with APCD to obtain emission inventories from the MOVES model for the existing conditions, No Action Alternative, and Proposed Action. Attachment 3 summarizes the MOVES inputs and assumptions used to model the emissions inventory of all MSATs listed previously.

4.2.3 Greenhouse Gases Analysis

CDOT has developed template language for GHG analyses, which is provided in the update to CDOT's *NEPA Manual*, Appendix F (2019b) and will be used for this project. The GHG analysis will include an emissions inventory of carbon dioxide, methane, and nitrous oxide using MOVES, which will partially satisfy the requirements of CRS 43-1-128. CDOT will coordinate with APCD to obtain emission inventories from the MOVES model for the existing conditions, No Action Alternative, and Proposed Action. Attachment 3 summarizes the MOVES inputs and assumptions used to model the emissions inventory of all GHGs listed previously.

4.3 Construction Analysis

Per the AQ-PLAG (CDOT 2019a), a qualitative discussion of potential construction-related emissions will be provided. Emission minimization and control measures will be provided as necessary and in accordance with the Colorado Air Quality Control Commission Regulation Number 1 (5 Code of Colorado Regulations [CCR] 1001-3) Emission Control for Particulate Matter, Smoke, Carbon Monoxide, and Sulfur Oxides and Number 3 (5 CCR 1001-5) Stationary Source Permitting and Air Pollutant Emission Notice Requirements.

Construction activities are anticipated to last less than 5 years. Therefore, construction emissions would not be subject to transportation conformity analysis.

5.0 References

Colorado Department of Transportation (CDOT). 2019a. *Air Quality Project-Level Analysis Guidance*. February.

Colorado Department of Transportation (CDOT). 2019b. *Technical Memorandum: Update to CDOT* NEPA Manual*, Appendix F – Standard Language (Global Climate Change Cumulative Effects Standard Language)*. Prepared by Rose Waldman. February 14.

Federal Highway Administration (FHWA). 2016. *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*. October.

U.S. Environmental Protection Agency (EPA). 1992. *Guideline for Modeling Carbon Monoxide From Roadway Intersections*. November.

U.S. Environmental Protection Agency (EPA). 2015. *Using MOVES2014 in Project-Level Carbon Monoxide Analyses*. March.

U.S. Environmental Protection Agency (EPA). 2021. *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas*. November.

U.S. Environmental Protection Agency (EPA). 2018. *PM Hot-spot Analyses: Frequently Asked Questions*. EPA-420-F-18-011. June.

Attachment 1
Traffic Data

Table A-1. 2050 Signalized Intersection Data

Intersection	Control Type	Existing						No Action Alternative						Proposed Action Alternative					
		a.m. Peak			p.m. Peak			a.m. Peak			p.m. Peak			a.m. Peak			p.m. Peak		
		Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume
Quebec St./ Sandcreek Dr. South	Signal	53.6	D	4,102	**73.1**	**E**	**4,861**	25.8	C	3,529	25.5	C	3,583	28.8	C	4,450	33.3	C	4,211
Quebec St./ I-270 WB On-Ramp	Signal	58.1	E	3,659	32.9	C	4,400	10.1	A	3,139	16.1	B	3,101	14.0	B	4,120	13.6	B	3,808
Vasquez Blvd./ E 56th Ave.	Signal	28	C	4,073	**119.5**	**F**	**4,919**	**300.7**	**F**	**6,186**	**198.1**	**F**	**7,606**	**112.5**	**F**	**6,056**	**127.4**	**F**	**7,250**
Vasquez Blvd./ E 60th Ave.	Signal	36.3	D	3,040	45.1	D	**4,461**	66.1	E	5,193	**147.7**	**F**	**6,834**	36.3	D	4,982	95.3	F	**6,374**
York St./ I-270 EB Ramp	Signal [a]	24.6	C	1,355	29.1	C	1,251	13.3	B	1,933	124.0	F	2,281	18.6	B	2,296	**170.5**	**F**	2,496
York St./ I-270 WB On-Ramp	Signal	58	E	1,760	**64.3**	**E**	1,570	9.7	A	2,061	7.8	A	2,224	14.1	B	2,431	8.1	A	2,380
Vasquez Blvd./ I-270 EB Off-Ramp	Signal [b]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6.0	A	4,967	4.5	A	5,847
Vasquez Blvd./ I-270 WB Off-Ramp	Signal [b]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.2	A	3,725	6.2	A	4,752

[a] Stop control under existing

[b] New intersection under Proposed Action

Note:

Bold is top three delay and top three highest volume.

Ave. = Avenue
Avg. = Average
Blvd. = Boulevard
Dr. = Drive
EB = eastbound
I-270 = Interstate 270
LOS = level of service
n/a = not applicable
St. = Street
WB = westbound

Table A-2. 2050 Daily Traffic Data Summary

Location	Segment Length (miles)	Segment Percentage	2 General Purpose Lanes (No Action)				2 General Purpose Lanes and 1 Express Lane (Proposed Action)					
			Total Vehicles	Truck %	Total Trucks	Diesel Trucks	Total Vehicles	Truck %	Total Trucks	Diesel Trucks	Truck Increase over No Action	Truck Increase over No Action (diesel only)
Mainline between I-70 and Quebec St.	0.8	14	114,233	8.4%	9,644	**8,357**	142,807	7.1%	10,148	**8,778**	504	**421**
Mainline between Quebec St. and Vasquez Blvd.	2.0	35	153,413	8.1%	12,488	**10,746**	193,775	6.8%	13,180	**11,324**	692	**577**
Mainline between Vasquez Blvd. and York St.	1.4	25	181,030	7.5%	13,611	**11,691**	240,486	6.0%	14,318	**12,271**	707	**580**
Mainline between York St. and I-76	1.0	18	154,537	7.7%	11,953	**10,302**	205,264	6.2%	12,676	**10,905**	723	**603**
Mainline between I-76 and I-25	0.5	9	182,533	6.8%	12,323	**10,616**	222,664	5.9%	13,059	**11,230**	736	**613**

Notes:

The daily traffic data for total vehicles, total trucks, and total truck percentages on the segments in above table are derived using the modified DRCOG Focus 2.3 models developed for the I-270 Improvements Project.

Based on the DRCOG Focus 2.3 model, the total trucks include medium trucks and heavy trucks. All heavy trucks were assumed to be diesel. For the medium trucks, the MOVES defaults were used to determine the percent of diesel which is estimated to be 78%. Based on this information, the average daily diesel trucks would be 5.5% of the total vehicles. This is conservative and higher than the APCD's 4.29% Diesel Truck VMT.

%= percent
APCD = Air Pollution Control Division
Blvd. = Boulevard
DRCOG = Denver Regional Council of Governments
I-25 = Interstate 25
I-70 = Interstate 70
I-76 = Interstate 76
St. = Street
VMT = vehicle miles traveled

Bold is total diesel trucks and increase in diesel trucks

Attachment 2
Traffic Analysis Methodology

Traffic Analysis for Air Quality Methodology

1.0 Introduction

This methodology summarizes the approach and assumptions the project team will be using to develop traffic data needed to perform the air quality analysis, including the particulate matter (PM) with diameter equal to or less than 2.5 micrometers ($PM_{2.5}$) and PM with diameter equal to or less than 10 micrometers (PM_{10}) analyses.

Attachment 1 to the Air Quality Analysis Work Plan will include the traffic data tables developed to screen carbon monoxide (CO) (Table 1) and PM_{10} (Table 2) for conformity. Traffic data developed for the $PM_{2.5}$/PM_{10} analysis and modeling will be available upon request. The traffic data for the air quality analysis will be based on the Denver Regional Council of Governments (DRCOG) Focus 2.3 2050 regional travel demand model (TDM). The TDM considers anticipated population and employment growth for every municipality within the DRCOG region as well as fiscally constrained planned improvements, including transit improvements.

The DRCOG 2040 Focus 2.1 TDM was adopted in 2019, before the start of the project's Environmental Assessment process in March 2020. This TDM was used as the basis for the project's traffic modeling and analysis. The DRCOG 2050 Focus 2.3 TDM was subsequently adopted in 2021.[1]

Based on the Clean Air Act, transportation conformity determinations must be made using the latest planning assumptions (*Code of Federal Regulations* Title 40 Section 93.110). Because the regional air quality conformity modeling was done using the 2050 TDM, the project-level air quality analysis for the I-270 project will use traffic data derived from the 2050 TDM.

2.0 Areas Identified for Traffic and Air Quality Modeling

2.1 Study Area Development for Emissions Inventory Modeling

The study area used to identify the roadway network for the emissions inventory is based on the project's general limits of disturbance (Figure 1). Modifications were made to extend the boundary to be consistent with the roadway network modeling planned for the $PM_{2.5}$/PM_{10} analysis, as discussed in Section 2.2.

[1] The team performed a sensitivity analysis between the model results for DRCOG Focus 2.1 2040 and DRCOG Focus 2.3 2050. The sensitivity analysis (Jacobs 2021) approach and results were documented and reviewed by the project team (FHWA and CDOT) to confirm no changes would be needed to the Proposed Action design or to the environmental analyses.

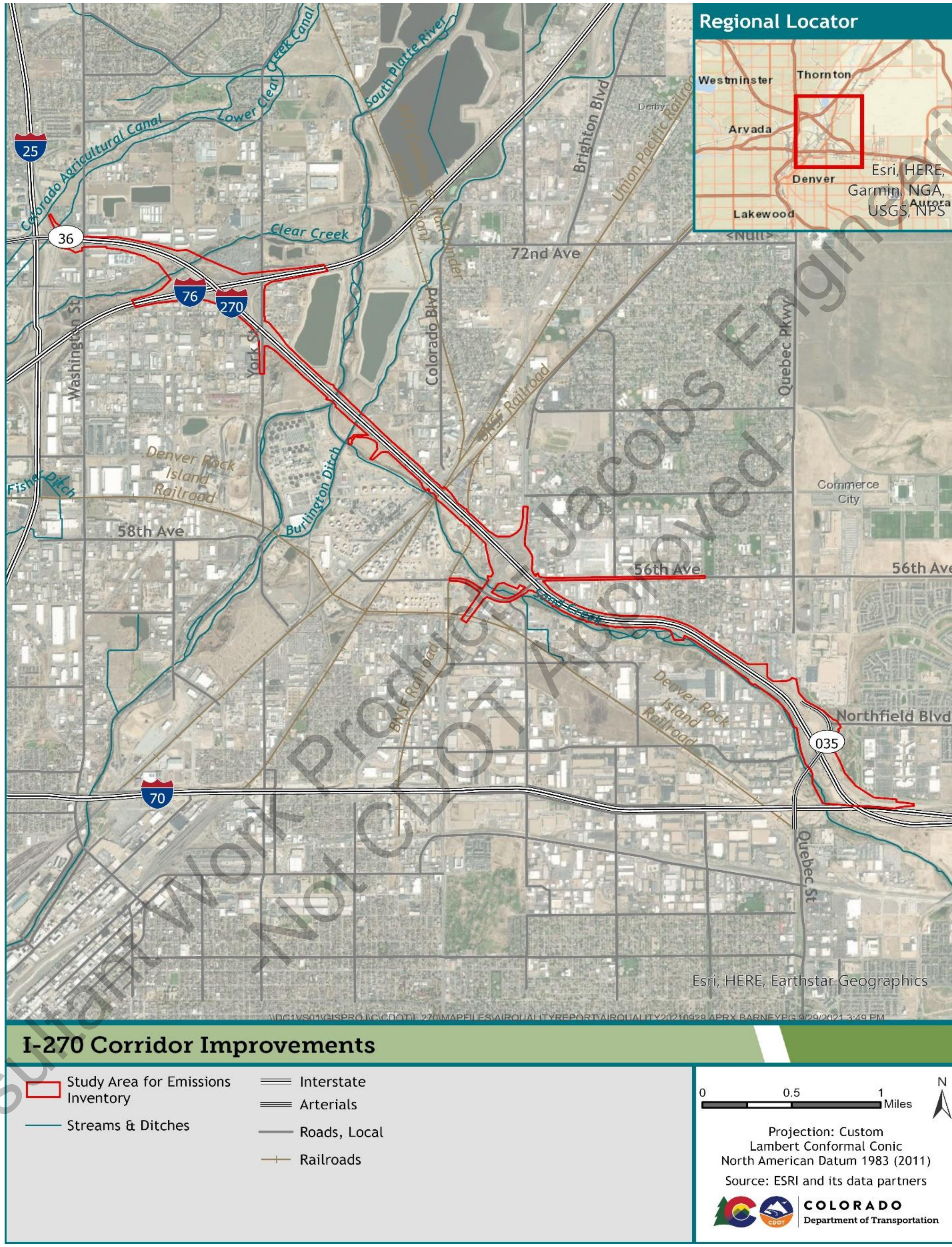

Figure 1. Study Area for Emissions Inventory Modeling

2.2 Locations used for Modeling $PM_{2.5}$/PM_{10} with AERMOD

Modeling locations for the $PM_{2.5}$/PM_{10} analysis were determined generally following the U.S. Environmental Protection Agency's (EPA's) *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (EPA 2021), and also considered areas where sensitive receptors will be located. The $PM_{2.5}$/PM_{10} analysis to be conducted will focus on the following two locations of the Interstate 270 (I-270) corridor: (1) between the Vasquez Boulevard interchange and west of the Quebec Street interchange, including east along East 56th Avenue, and (2) from west of the Interstate 76 (I-76) interchange to east of the York Street interchange.

The limits of the roadway networks for the traffic modeling will be consistent with the locations identified for receptor grids for the $PM_{2.5}$/PM_{10} modeling. The receptor grids for the two selected locations extend 500 meters from the edge of the roadway (EPA 2018 and 2021).

The traffic engineers will develop roadway models in TransCAD and Synchro within Figures 2 and 3 for the following:

- Surface streets, ramp junctions, and ramp meter locations
- No Action conditions
- Proposed Action with the express lane operating option for the two locations

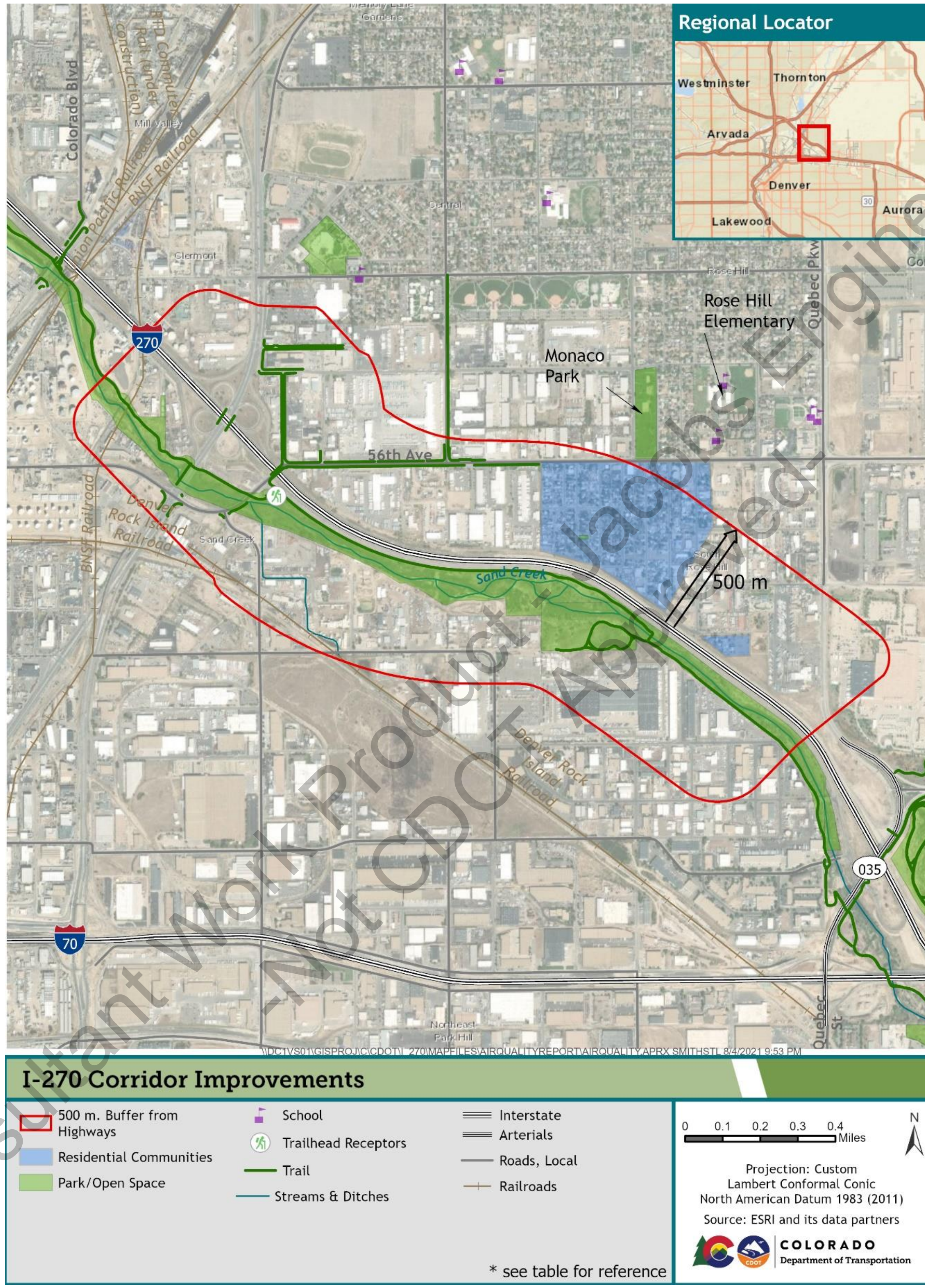

Figure 2. $PM_{2.5}$/PM_{10} Modeling Location 1

Figure 3. $PM_{2.5}$/PM_{10} Modeling Location 2

3.0 Traffic Data Development

This section describes the basic steps and tools that will be used to develop traffic data required to support the air quality analysis. There are two sets of traffic data developed: at roadway link level and at approach levels for intersections.

3.1 Roadway Link Level Traffic Data

The traffic data at roadway link level will be derived using the modified DRCOG Focus 2.3 models developed for the I-270 Improvements Project. The roadway link level traffic volumes, speeds, and vehicle miles travelled taken directly from these updated models will be used for the analysis. The DRCOG TDM- generates traffic data for different time periods in a day and will be directly used for the analysis. The data will be summarized for the following time periods:

- Morning (a.m.) peak period: 6 a.m. to 9 a.m.
- Midday period: 9 a.m. to 3 p.m.
- Evening (p.m.) peak period: 3 p.m. to 7 p.m.
- Evening/night period: 7 p.m. to 6 a.m.

After the DRCOG Focus 2.3 models are obtained, the roadway networks will be reviewed and then saved as a 2050 No Action model and a 2050 Proposed Action model. Within each model, the roadway networks will be developed to match the following:

- 2050 No Action – For design year 2050, the No Action Alternative includes the DRCOG 2050 roadway network minus the proposed project improvements, notably the I-270 express lanes, auxiliary lanes, and ramp improvements at the interchanges. The 2050 TDM No Action network includes express lanes on U.S. Highway 36 (US-36), I-25, and I-70 because these are included in the fiscally constrained long-range plan.
- 2050 Proposed Action (Express Lane Operating Option) – The adopted 2050 TDM includes the express lanes for I-270. However, minor modifications will be needed to make the 2050 TDM accurately reflect the Proposed Action. The traffic engineers will modify the roadway network to accurately reflect the interchange geometry and other improvements of the project.

Once the networks are modified and complete, the traffic engineers will start demand model runs and provide the complete input and output data files for speed and volumes to the project team.

3.2 Intersection Level Traffic Data

The majority of the air quality analysis to be performed relies on roadway link level traffic information that comes directly from the modified DRCOG TDM using TransCAD. However, the TDM does not provide the necessary details related to the impacts of traffic control at signalized intersections; this information will be obtained by performing a microscopic analysis in Synchro. The primary data that Synchro provides is the ability to better evaluate the operational conditions of traffic signals and other intersection controls such as ramp meters, to provide information about queuing and roadway link speeds. This includes the ability to evaluate the impact of ramp metering for the I-270 on-ramps within the study area.

3.2.1 Traffic Volumes for Intersections

This section discusses the procedures the project team will follow to develop the traffic volumes for the study intersections. For the air quality analysis, traffic conditions during a 24-hour period will be represented by peak and off-peak conditions. Based on EPA's $PM_{2.5}$/PM_{10} hot spot analysis guidance (EPA 2015), the peak-hour volume can be used to represent conditions over a peak morning (a.m.) and peak evening period (p.m.). The remaining hours of the day can be represented by the average off-peak hourly volume.

The TDM does not provide turning movement data, but it does provide roadway link volumes on the approaches to the intersections. Therefore, the project team will rely on the National Cooperative Highway Research Program Report 765 (TRB 2014) and standard practices to develop 2050 a.m. and p.m. peak hour turning movement volumes at these intersections.

Between the a.m. and the p.m. peak hour traffic volumes, the worst hour traffic will be used as the volumes for the peak hours condition. The worst peak-hour volumes will be used to represent the volumes during the 3 hours of the morning (6 a.m. to 9 a.m.) peak and 4 hours of the evening (3 p.m. to 7 p.m.) peak (EPA 2015). The a.m. and p.m. peak periods represent 7 hours of peak hours condition in a 24-hour day.

For the remaining 17 hours of the day, the average off-peak condition will be used. The volumes for an average off-peak hour will be developed using the following process:

1. Daily traffic counts on weekdays in 2019 from the Continuous Count Data at Location ID 000507 on I-270 will be obtained via https://cdot.ms2soft.com/tcds/tsearch.asp?loc=Cdot&mod=.
2. The count data will be evaluated to determine how much of the daily traffic occurred during the worst peak hour, showing that 6.15 percent of the daily traffic occurs during the highest peak hour.
3. The air quality modeling assumes the peak hour condition will occur for 7 hours each day—3 hours in the morning and 4 hours in the evening—which means 43 percent (6.15 percent times 7) of the daily traffic would occur during the 7-hour peak hour condition. This leaves 57 percent of the daily traffic to occur during the off-peak hour condition.
4. Using the 57 percent value determined that about 3.35 percent of the daily traffic occurs during a single off-peak hour (divide 57 percent by 17 off-peak hours).
5. Dividing this off-peak percentage by the peak-hour percentage (3.35 divided by 6.15) indicates that the average off-peak-hour traffic volume could be estimated by multiplying the peak-hour volume by a factor of 0.54.

For example, if the worst peak hour of traffic consisted of 200 vehicles, then all 7 peak hours would total 1,400 vehicles or 200 vehicles for each of peak hour, while the other 17 off-peak hours would be 108 vehicles (200 vehicles times 0.54) for each off-peak-hour.

3.2.2 Synchro Analysis

The Synchro roadway networks will be pulled over from the Environmental Assessment traffic analysis for modifications. The models will be populated with the turning movement volumes necessary for Synchro to evaluate the operating conditions.

The project team will evaluate the operations for both the peak hour condition and off-peak hour condition to support the 24-hour period for air quality intersection analysis. The Synchro outputs will be link speeds, and those speeds will reflect the impact of queuing caused by traffic control, primarily signals, at intersections and ramp meters. Because queue lengths vary from intersection to intersection and time period to time period, the project team will determine the queue lengths and link speeds at each intersection similar as shown on Figure 4. The queue lengths from the Synchro analysis represent the stopped vehicles as depicted in red on the figure. The green areas on the figure will represent the posted speeds, and the yellow segments will represent an average speed between stopped vehicles at intersections to the cruising vehicles on the other side of intersection. An average acceleration rate would be assumed based on *Highway Capacity Manual* guidance (TRB 2020).

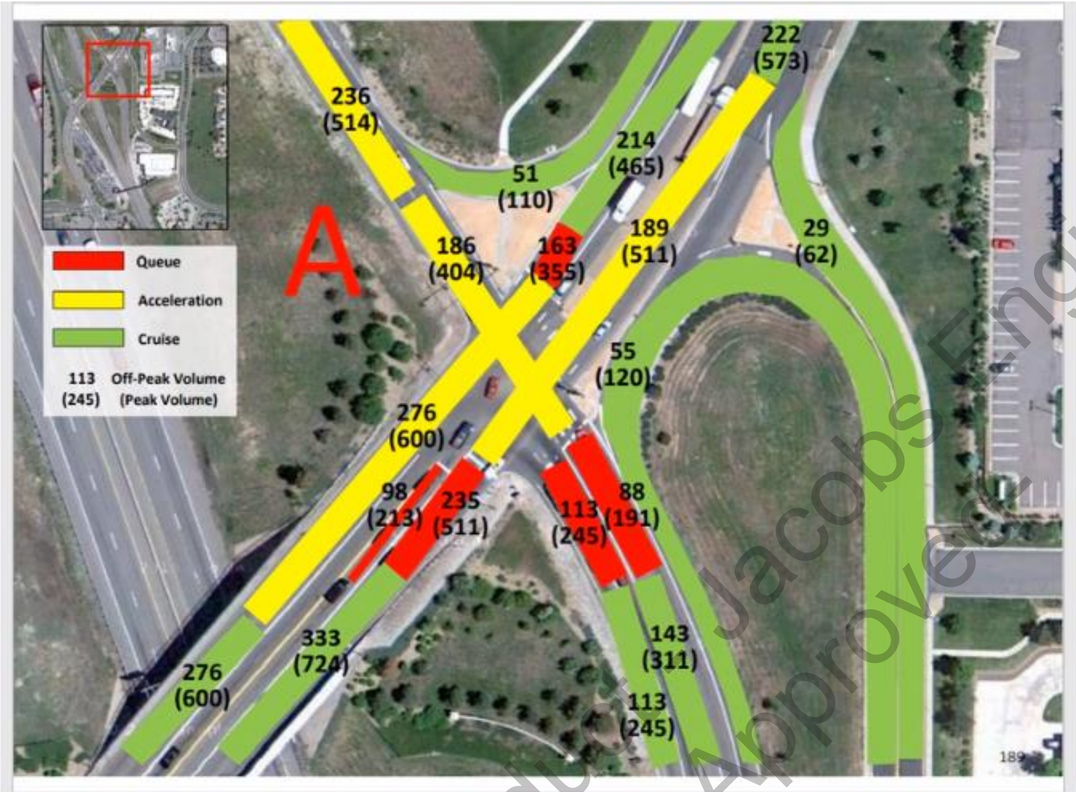

Figure 4. Example of Queue, Acceleration, and Cruise Speeds within an Intersection
Source: EPA 2018

4.0 Roadway Link Alignment, Grade, and Distance for Traffic

Based on the locations selected for the $PM_{2.5}$/PM_{10} analysis, a traffic data spreadsheet will be developed to detail and summarize inputs for each unique roadway link segment. This section describes the basic steps and tools to be used in deriving the roadway link geometry and provided in a spreadsheet to support the air quality analysis.

4.1 Alignments, Grades, and Distance

Major roadways that fall within the limits of each modeling location described in Section 2.2 spatially replicated in Microstation by drawing a baseline atop the planimetrics or aerial image. The baseline linework will then be converted to geometry within InRoads and assigned stationing and direction. Stationing the alignments will allow for roadway alignment distances to be fed into the air quality input spreadsheet as depicted on Figure 5. The alignments will also be compared to the as-built construction plans to check if the alignments were reasonable and that most ramp alignments were stationed to match the as-built plans. Average grades for the alignment will be determined by subtracting the start alignment elevation from the end alignment elevation and dividing by the length of the link alignment. Elevations will be gathered from as-built plans or from the conceptual design profiles generated for new alignments.

Segment Number	Segment Label	Roadway Type	Roadway Station Number		Elevations		Segment Length	Avg. Grade (+ or -)
			Start	End	Start	End	mile	%
Segments included in Study Area West								
41a	I-270 EB btw I-25 and off-ramp to I-76 NB - GP	mainline	136+00.00	143+00.00	5156.5	5163.3	0.13	1.0%
41b	I-270 EB btw I-25 and off-ramp to I-76 NB - EL	mainline	136+00.00	143+00.00	5156.5	5163.3	0.13	1.0%
1a	I-270 EB btw off-ramp to I-76 NB and on-ramp from I-76 SB - GP	mainline	143+00.00	166+00.00	5163.3	5136.1	0.44	-1.2%
1b	I-270 EB btw off-ramp to I-76 NB and on-ramp from I-76 SB - EL	mainline	143+00.00	166+00.00	5163.3	5136.1	0.44	-1.2%

Figure 5. Example of Air Quality Spreadsheet Inputs

Source: Jacobs

Notes:

Avg=average

btw=between

EL=express lane

GP=general purpose

NB=northbound

The baselines for the roadway links will also be exported to a KMZ file and sent to FHWA for review and acceptance. These roadway links were identified for the development of traffic data and will be used as a starting point for American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) modeling. The final roadway links and lengths developed for AERMOD will be refined by the AERMOD modeler. Once the modeled roadway network is complete and reviewed and accepted by FHWA, the start and end points will be translated to XY coordinate (easting and northing) format and added into the traffic data spreadsheet.

5.0 References

Jacobs. 2021. *I-270 Corridor Sensitivity Test – Focus 2.1 2040 TDM Compared with the Updated Focus 2.3 2050 TDM*. Prepared for Colorado Department of Transportation.

Transportation Research Board (TRB). 2014. *National Cooperative Highway Research Program (NCHRP) Report 765: Analytical Travel Forecasting Approaches for Project-Level Planning and Design.*

Transportation Research Board (TRB). 2020. *Highway Capacity Manual, 6th Edition: A Guide for Multimodal Mobility Analysis*. Washington, D.C.: National Academies of Science, Engineering, and Medicine.

U.S. Environmental Protection Agency (EPA). 2021. *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in PM2.5 and PM10 Nonattainment and Maintenance Areas*

U.S. Environmental Protection Agency (EPA). 2018. *2018 3-Day PM Hot-spot Training Course Material, Module 3: Selecting an Air Quality Model, Data Inputs, Receptors*.

Attachment 3
MOVES Input and Assumptions

I-270 MOVES Modeling Methodology

1.0 Introduction

This document summarizes the methodology for the Motor Vehicle Emission Simulator (MOVES) modeling that will be conducted by the Air Pollution Control Division (APCD) to support the quantitative emission analyses for the Interstate 270 (I-270) Corridor Improvement Project. The MOVES model will be run for two purposes:

1. To complete a vehicle emissions inventory for criteria pollutants, mobile source air toxics (MSATs), and greenhouse gases (GHGs) in the study area.
2. To obtain emission factors for the carbon monoxide (CO) hot spot analysis.

All MOVES model input and output files will be included in the project record and available by request.

The methodology for the MOVES modeling that will be conducted for the particulate matter (PM) analysis will be provided in Appendix G.

2.0 Emission Inventories for Criteria Pollutants, Mobile Source Air Toxics, and Greenhouse Gases

The following section summarizes the model selection and parameters that will be used to create an onroad run specification file (RunSpec) in MOVES for estimating vehicle emissions for criteria pollutants, MSATs, and GHGs. The U.S. Environmental Protection Agency (EPA) guidance *Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity* (2020) and *Using MOVES for Estimating State and Local Inventories of Onroad Greenhouse Gas Emissions and Energy Consumption* (2016) and the Federal Highway Administration (FHWA) *Frequently Asked Questions (FAQ) Conducting Quantitative MSAT Analysis for FHWA NEPA Documents* (2016) will be consulted and followed where applicable.

2.1 Model Selection

On January 7, 2021, EPA announced in the *Federal Register* the official release of MOVES3 for emissions inventories in state implementation plans (SIPs) and transportation conformity. This announcement started a 2-year grace period for use of MOVES3 in transportation conformity analyses that ends on January 9, 2023. Through the interagency consultation process, MOVES3 was selected and will be used instead of MOVES2014.

The MOVES3 model will be run using the onroad module to calculate mobile source emission factors for existing and future conditions. The model used the inventory calculation type at the county scale to estimate vehicle emission factors from the study area.

Where available, project-specific data on a roadway link-by-link basis will be used to develop MOVES inputs while regional-specific data that are consistent with the regional emissions analyses conducted for the SIPs will be used for other inputs.

2.2 Model RunSpec

A RunSpec will be created to define the parameters of the model. Tables 1 through 4 summarize the MOVES inputs for the RunSpec as defined in the navigation panel of the MOVES graphical user interface (GUI). Subsections 2.2.1 through 2.2.11 describe input options needed for the RunSpec.

Table 1. MOVES RunSpec Option

Navigation Panel	Model Selection
Scale	County scale; inventory calculation type
Time Span	Hourly time aggregation including weekdays only, all hours for January/April/July/October
Geographic Bounds	Adams County
Onroad Vehicle Types	All MOVES3 vehicle and fuel type combinations
Road Type	Urban unrestricted and restricted access
Pollutants and Processes	See Table 2 and Section 2.2.5
General Output	Units of grams
Output Emissions Detail	Output included speciation of emissions by fuel type to differentiate diesel PM from other fuel type PM.
Time Aggregation	24-hour

Note: PM = particulate matter

Table 2. MOVES RunSpec MSAT Pollutants

MOVES Pollutant ID	Pollutant Name	MOVES Pollutant ID	Pollutant Name
Polycyclic Organic Matter			
68	Dibenzo[a,h]anthracene particle	168	Dibenzo[a,h]anthracene gas
69	Fluoranthene particle	169	Fluoranthene gas
70	Acenaphthene particle	170	Acenaphthene gas
71	Acenaphthylene particle	171	Acenaphthylene gas
72	Anthracene particle	172	Anthracene gas
73	Benz[a]anthracene particle	173	Benz[a]anthracene gas
74	Benzo[a]pyrene particle	174	Benzo[a]pyrene gas
75	Benzo[b]fluoranthene particle	175	Benzo[b]fluoranthene gas
76	Benzo[g,h,i]perylene particle	176	Benzo[g,h,i]perylene gas
77	Benzo[k]fluoranthene particle	177	Benzo[k]fluoranthene gas
78	Chrysene particle	178	Chrysene gas
81	Fluorene particle	181	Fluorene gas
82	Indeno[1,2,3,c,d]pyrene particle	182	Indeno[1,2,3,c,d]pyrene gas
83	Phenanthrene particle	183	Phenanthrene gas
84	Pyrene particle	184	Pyrene gas
Primary Exhaust PM_{10} – Total (Required MOVES pollutants listed here)			
100	Primary Exhaust PM_{10} - Total	115	Sulfate Particulate

Table 2. MOVES RunSpec MSAT Pollutants

MOVES Pollutant ID	Pollutant Name	MOVES Pollutant ID	Pollutant Name
110	Primary Exhaust $PM_{2.5}$ - Total	118	Composite - NonECPM
112	Elemental Carbon	119	H_2O (aerosol)
Naphthalene			
185	Naphthalene gas	23	Naphthalene particle
All Other MSATs			
24	1,3-Butadiene	20	Benzene
26	Acetaldehyde	41	Ethyl Benzene
27	Acrolein	25	Formaldehyde

Notes:

The primary exhaust PM_{10} pollutants listed represent the required/prerequisite pollutants when selecting primary exhaust PM_{10} in the moves model. The primary exhaust PM_{10} output from the MOVES model incorporates these pollutants in its modeled total, and they do not need to be individually summed to get PM_{10} emissions.

$PM_{2.5}$ = particulate matter with diameter equal to or less than 2.5 microns
PM_{10} = particulate matter with diameter equal to or less than 10 microns

Table 3. MOVES RunSpec Emission Processes

ID	Process
1	Running Exhaust
15	Crankcase Running Exhaust
11	Evaporative Permeation
13	Evaporative Fuel Leaks

Table 4. MOVES County Data Manager Inputs

County Data Manager Tab	Data Source
Meteorology Data	MOVES default
Source Type Population	APCD Provided Data
Age Distribution	APCD Provided Data
Fuel	MOVES default
I/M Program	APCD Provided Data
Vehicle Type VMT	Project-specific Data
Average Speed Distribution	Project-specific Data
Road Type Distribution	Project-specific Data

Notes:

I/M = inspection and maintenance
VMT = vehicle miles traveled

2.2.1 Model Years and Time Periods

The emission inventories will be modeled for existing conditions 2016, No Action 2050, and Proposed Action (express lane only) 2050. The Denver Regional Council of Governments (DRCOG) Travel Demand Model (TDM) Focus 2.3 provides traffic data for the following time periods, and therefore, the same time periods will be used in the MOVES modeling:

- AM1: 6 a.m. to 7 a.m.
- AM2: 7 a.m. to 8 a.m.
- AM3: 8 a.m. to 9 a.m.
- PM1: 3 p.m. to 5 p.m.
- PM2: 5 p.m. to 6 p.m.
- PM3: 6 p.m. to 7 p.m.
- OP1: 11 p.m. to 6 a.m.
- OP2: 9 a.m. to 11 a.m.
- OP3: 11 a.m. to 3 p.m.
- OP4: 7 p.m. to 11 p.m.

2.2.2 Geographic Bounds

The proposed project is located within portions of Adams and Denver counties. However, Adams County will be selected as the representative county in the MOVES runs because the proposed project is located mostly within Adams County.

2.2.3 Onroad Vehicle Types

The MOVES model will be run using data from the DRCOG TDM for 2050 and 2016 (interpolated from 2015 and 2017). Emission factors will be calculated by MOVES on an aggregated hourly basis for six Highway Performance Monitoring System (HPMS) vehicle types and multiplied by the link (roadway) VMT from the TDMs. The following are the six HPMS vehicle types:

- Motorcycles
- Passenger cars
- Light trucks
- Buses
- Motor home, refuse, or single-unit short/long-haul trucks
- Combination-unit short/long-haul trucks

Hourly vehicle mix data for the six vehicle types will be determined as a 5-year average from the most recently available Colorado Department of Transportation (CDOT) long-term (permanent) and short-term (temporary) automated traffic recorder (ATR) data from 2015 to 2019.

FHWA uses 13 vehicle classes and requires states to maintain a system of traffic counters (that is, ATRs) to count vehicles by these 13 classes. CDOT has such a system of ATRs that they permanently maintain on selected principle arterials and freeways. CDOT also supplements these permanent counters with temporary counters on lower-level facilities and roadways.

2.2.4 Road Type

The roadway types that will be used in the MOVES run include urban unrestricted and restricted access roadways in the study area.

2.2.5 Pollutants

Vehicle emissions inventories of the study area will be run for each of the analysis years for the following pollutants.

Criteria Pollutants

- CO
- Nitrogen dioxide
- PM_{10}
- $PM_{2.5}$
- Nitrogen oxides
- Volatile organic compounds

PM_{10} and $PM_{2.5}$ emissions from vehicle travel include the vehicles exhaust, brake and tire wear, and re-entrained road dust from the roadway surface.

MOVES does not calculate particulate matter emissions from road dust. To estimate road dust and sanding emissions for this analysis, emissions factors from the latest regional transportation conformity analysis and modeling for PM_{10} were used. Emissions factors included in the conformity modeling vary with road type and jurisdiction maintaining the road. Since the goal of this analysis is simply to document the trend in emissions, an average road dust emissions rate was used for the entire study area (unlike the actual hotspot analysis, where link-specific emissions rates were used). This rate was calculated using the VMT and controlled sanding and road dust emissions estimates from the most recent PM_{10} maintenance conformity modeling which was based on Section 3.4 of the PM_{10} SIP Technical Support Document (TSD).

It should be noted that the approach of using a road-dust emission rate assumes an infinite reservoir of dust and sand on the highway surface that is re-suspended into the air in direct proportion to VMT. This is, thus, a conservative approach to estimating airborne dust since, in reality, the dust and sand would be gradually depleted from the road surface as it was re-suspended and settled out away from the highway.

MSATs

- 1,3-butadiene
- Acetaldehyde
- Acrolein
- Benzene
- Diesel PM
- Ethylbenzene
- Formaldehyde
- Naphthalene
- Polycyclic organic matter

GHGs

- Carbon dioxide (CO_2)
- Methane
- Nitrous oxide
- Carbon dioxide equivalent (CO2e)

The CO2e will be modeled using the 100-year global warming potential (GWP) of individual gases. The GWP of a GHG is its ability to trap extra heat in the atmosphere over a period of time (usually 100 years) relative to CO_2. The GWP was developed as a common scale for measuring and comparing the climate effects of different gases. Table 5 summarizes the GWP factors used in MOVES3.

Table 5. GWP Factors in MOVES3

Pollutant	GWP
CO_2	1
Methane	25
Nitrous Oxide	298

2.2.6 Meteorology Data

Meteorological data that will be used in the inventory modeling are MOVES defaults for January, April, July, and October which will be based on a 5-year average of data from the National Weather Service representing the conditions of each quarter of the year.

2.2.7 Vehicle Age Distribution

The vehicle age distribution input for the modeling will be based on a composite of vehicle registration data for 2017 from seven Denver area counties (Adams, Arapaho, Boulder, Broomfield, Denver, Douglas, and Jefferson).

2.2.8 Fuel

Regional-specific parameters for fuel composition were not available. Therefore, the default parameters in MOVES3 will be used per EPA guidance (2020) even though this modeling effort is not for SIP or conformity purposes.

2.2.9 Inspection and Maintenance Parameters

Existing and anticipated future vehicle I/M program parameters for the Denver metropolitan area will be provided by APCD.

2.2.10 Average Speed

Average speed data for each hour and roadway link within the air quality study area will be derived from the project's traffic study specific to each scenario.

2.2.11 Post Processing

Annual average weekday VMT for each link and hour will be multiplied by the average of hourly emission factors for each hour and speed (rounded to the nearest mile per hour) for the two MOVES runs for January and July to develop annual emissions. The modeling results will show vehicle emissions differences between existing and future (No Action and Proposed Action) conditions.

3.0 Carbon Monoxide Emission Factors for Project Level Hotspot Conformity Analysis

The following sections summarize steps of MOVES modeling CO emission factors to complete project-level CO hot spot analyses. The modeling followed the EPA guidance *Using MOVES2014 in Project-Level Carbon Monoxide Analyses* (2015). Although MOVES3 was the selected model, this guidance is still applicable to CO hot spot analyses.

3.1 MOVES Runs

MOVES will be run for peak winter morning (January).

Emission factors will be modeled using MOVES for the free-flow speeds and idling for the analysis year of 2050. Intersection-specific emission factors that will be used for the CO hot spot modeling will be obtained by selecting or scaling the emission factors at the corresponding travel speed. A speed of 0 miles per hour (mph) will be used to calculate an idle emission factor in units of grams per hour.

3.2 Run Specification Inputs

A RunSpec will be created to define the parameters of the model. Table 6 summarizes the MOVES inputs for the RunSpec as defined in the navigation panel of the MOVES GUI. The following subsections describe input options needed for the RunSpec.

Table 6. MOVES RunSpec Options

Navigation Panel	Model Selection
Scale	Project scale; inventory calculation type
Time Span	Hour; weekdays; January
Geographic Bounds	Denver County
Vehicles	All MOVES3 vehicle and fuel type combinations
Road Type	Urban unrestricted access
Pollutants and Processes	CO; running exhaust and crankcase running exhaust
General Output	Units of grams and miles

3.3 Project Data Manager

After the RunSpec is created, an input database table will be created before running MOVES. This will be done using the Project Data Manager to enter project-specific data. Table 7 lists the MOVES Project Data Manager inputs.

Table 7. MOVES Project Data Manager Inputs

Project Data Manager Tab	Data Source
Meteorology Data	MOVES default
Age Distribution	APCD Provided Data
Fuel	MOVES default
I/M Program	APCD Provided Data
Link Source Type	MOVES Data
Links	Project-specific Data
Link Drive Schedule	MOVES default

3.3.1 Meteorology Data

Meteorological inputs will include the MOVES defaults for January, which will be based on a 5-year average of data from the National Weather Service. The results will be averaged to represent an average annual weekday daily average emission rate.

3.3.2 Vehicle Age Distribution

The vehicle age distribution input for the modeling will be based on a composite of vehicle registration data for 2017 from seven Denver area counties (Adams, Arapaho, Boulder, Broomfield, Denver, Douglas and Jefferson).

3.3.3 Fuel

Regional-specific parameters for fuel composition were not available. Therefore, the default parameters in MOVES3 will be used per EPA guidance (2020) even though this modeling effort is not for SIP or conformity purposes.

3.3.4 Inspection and Maintenance Parameters

Existing and anticipated future vehicle I/M program parameters for the Denver metropolitan area will be provided by APCD.

3.3.5 Link Source Type

Link source types will be modeled in MOVES to obtain emission factors for each of the 13 MOVES vehicle types. The MOVES source types will then be combined into the six HPMS vehicle types using MOVES defaults. The hourly VMT mix by HPMS class will be derived from CDOT ATR data and used to combine the six HPMS class emission factors into a single maximum peak hour emission factor.

3.3.6 Links

All roadway links will be modeled using a volume of one vehicle and length of 1 mile for rural unrestricted road type. Free-flow emission factors will be modeled for speeds between 5 and 55 mph with 5-mph increments as well as an idle condition (0 mph). All links will be modeled at a zero grade.

4.0 References

U.S. Environmental Protection Agency (EPA). 2015. *Using MOVES2014 in Project-Level Carbon Monoxide Analyses*. EPA-420-B-15-028. March. https://nepis.epa.gov/Exe/ZyPdf.cgi?Dockey=P100M2FB.pdf.

U.S. Environmental Protection Agency (EPA). 2016. *Using MOVES for Estimating State and Local Inventories of Onroad Greenhouse Gas Emissions and Energy Consumption.* EPA-420-B-16-059. June. https://www.ourenergypolicy.org/wp-content/uploads/2016/09/P100OW0B.pdf.

U.S. Environmental Protection Agency (EPA). 2020. *Using MOVES to Prepare Emission Inventories in State Implementation Plans and Transportation Conformity.* EPA-420-B-20-052. November. https://www.epa.gov/sites/default/files/2020-11/documents/420b20052.pdf.

Federal Highway Administration (FHWA). 2016. *Frequently Asked Questions (FAQ) Conducting Quantitative MSAT Analysis for FHWA NEPA Documents*. HEP-15-056. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/moves_msat_faq.pdf.

Appendix B
Summary of IAC and Subsequent Meetings

Appendix B. Summary of IAC and Subsequent Meetings

An interagency consultation (IAC) meeting for the project was held on January 26, 2021. Participants from the Federal Highway Administration (FHWA), Colorado Department of Transportation (CDOT), U.S. Environmental Protection Agency (EPA), Colorado Department of Public Health and Environment Air Pollution Control Division (APCD), and Jacobs attended the meeting to discuss the approach for air quality analysis under transportation conformity requirements and the National Environmental Policy Act (NEPA). Additional meetings were held with the IAC participants together and separately to discuss follow-up items and the modeling data needs. Meeting minutes were developed and distributed to the attendees.

The criteria defined in 40 *Code of Federal Regulations* 93.123(b)(1) regarding project of air quality concern (POAQC) determinations were reviewed and discussed. Based on the project traffic data, including the projected increase in diesel truck traffic, FHWA and CDOT staff determined that the project does not meet the criteria to be considered a POAQC. This conclusion and supporting data were presented at the January 26, 2021, IAC meeting. EPA stated during that meeting that they would like to confer with Office of Transportation and Air Quality (OTAQ) before giving an opinion on the determination of POAQC. In addition, APCD wanted CDOT to look into the diesel truck percentage further.

A technical discussion meeting was held with all IAC participants on February 9, 2021, to follow up with EPA and APCD and discuss the modeling data needs. At this time, EPA was still discussing with OTAQ and had not provided its opinion on POAQC determination. During this meeting, Jacobs presented the supporting data again and further explained the steps and resources used to derive a diesel truck percentage for the project. APCD did not have any further questions.

At a follow-up meeting held with all IAC participants on March 17, 2021, EPA stated that FHWA, as federal lead agency, would make the project's POAQC determination. FHWA and CDOT also indicated that they intend to conduct particulate matter (PM) hot spot analysis due to air quality concerns in the study area and sensitivity to environmental justice areas. EPA agreed with conducting the PM hot spot analysis and suggested that the PM hot spot analysis follow the conformity modeling guidance to provide results that are supported by the regulatory requirements. CDOT proposes to conduct an air quality analysis that is beyond what is typically required in a NEPA document including analysis of PM less than 2.5 microns in aerodynamic diameter.

On April 23, 2021, a meeting was held with all IAC participants, and included the Denver Regional Council of Governments (DRCOG) to discuss analysis years and data needed from the DRCOG regional model, background concentrations and exceptional events, and the MOVES data request for APCD. During this meeting, it was still undecided whether the PM analysis would be conducted under conformity or NEPA.

Additional follow-up meetings were held separately with FHWA, CDOT, APCD, and Jacobs on April 1 and 29, 2021. On April 1, 2021, the meeting discussion included the data request for APCD, vehicle types modeled in MOVES, AERMOD-ready meteorological data, background concentrations, re-entrained dust, and the emissions inventory. On April 29, 2021, the MOVES data request was reviewed in greater detail to ensure that everyone agreed with the input and output modeling files.

Another follow-up meeting was held separately with FHWA, CDOT, and EPA on June 9, 2021. The purpose of the meeting was to discuss whether the I-270 project should be designated as a POAQC. The proposed approach was to conduct the air quality analysis as part of the NEPA process and focus on environmental justice communities, and not under conformity. EPA stated during that meeting that they support the approach, but would like to discuss with FHWA R8 Staff and OTAQ to ensure there are no mis-steps that would impact any of the agencies in the future. Other discussion items included the research monitoring program, Colorado Senate Bill 260 requirements (now coded as Colorado Revised Statute 43-1-128), and the approach for PM modeling and analysis.

Another IAC meeting was held on April 4, 2022 to provide agencies with traffic data and air quality updates and present the results of the public outreach air quality survey. EPA suggested reviewing the existing condition diesel percentage to ensure heavy diesel is captured accurately under existing conditions. None of the meeting participants noted questions or concerns with the air quality updates. EPA asked how recipients were identified for the distribution of the air quality survey and noted that it is important to consider that EJ participants might not have access to computers when targeting these potentially affected residents.

Appendix C

MOVES Inputs and Results for Emissions Inventory

Pollutant Name	i27016inv	i27050nbinv	i27050bldinv
Criteria Pollutants			
Carbon Monoxide (CO)	4,239,076.55	1,209,713.50	1,206,310.54
Nitrogen Dioxide (NO2)	87,653.35	34,530.12	30,072.04
Oxides of Nitrogen (NOx)	674,059.16	90,315.95	79,268.51
Volatile Organic Compounds	94,684.06	19,939.45	18,917.17
Primary Exhaust PM10 - Total	13,534.55	1,967.27	1,978.98
Primary PM10 - Brakewear Particulate	20,360.51	24,978.35	31,940.56
Primary PM10 - Tirewear Particulate	8,244.86	10,668.14	10,902.30
PM-10 reintrained dust	182,553.24	250,833.43	242,534.75
PM-10 TOTAL	224,693.16	288,447.20	287,356.60
Primary Exhaust PM2.5 - Total	12,311.00	1,763.16	1,775.09
Primary PM2.5 - Brakewear Particulate	2,545.06	3,122.29	3,992.57
Primary PM2.5 - Tirewear Particulate	1,236.72	1,600.21	1,635.34
PM-2.5 reintrained dust	45,638.31	62,708.36	60,633.69
PM-2.5 TOTAL	61,731.10	69,194.02	68,036.69

Pollutant Name	i27016inv	i27050nbinv	i27050bldinv
POM			
Acenaphthene gas	7.38	0.29	0.30
Acenaphthene particle	0.00	0.00	0.00
Acenaphthylene gas	19.98	1.22	1.25
Acenaphthylene particle	0.08	0.01	0.01
Anthracene gas	5.95	0.23	0.24
Anthracene particle	0.95	0.01	0.01
Benz(a)anthracene gas	1.05	0.04	0.04
Benz(a)anthracene particle	2.44	0.11	0.11
Benzo(a)pyrene gas	0.02	0.00	0.00
Benzo(a)pyrene particle	2.45	0.27	0.27
Benzo(b)fluoranthene gas	0.27	0.03	0.03
Benzo(b)fluoranthene particle	1.07	0.13	0.13
Benzo(g,h,i)perylene gas	0.01	0.00	0.00
Benzo(g,h,i)perylene particle	4.92	0.74	0.72
Benzo(k)fluoranthene gas	0.27	0.03	0.03
Benzo(k)fluoranthene particle	0.91	0.13	0.13
Chrysene gas	0.67	0.04	0.04
Chrysene particle	1.70	0.09	0.09
Dibenzo(a,h)anthracene gas	0.00	0.00	0.00
Dibenzo(a,h)anthracene particle	0.07	0.01	0.01
Fluoranthene gas	9.34	0.38	0.39
Fluoranthene particle	3.60	0.04	0.04
Fluorene gas	13.13	0.59	0.61
Fluorene particle	1.49	0.00	0.00
Indeno(1,2,3,c,d)pyrene gas	0.00	0.00	0.00
Indeno(1,2,3,c,d)pyrene particle	1.89	0.28	0.27
Phenanthrene gas	25.86	1.59	1.64
Phenanthrene particle	3.73	0.04	0.04
Pyrene gas	11.01	0.43	0.44
Pyrene particle	5.10	0.05	0.04

Primary Exhaust PM10 - Total			
Primary Exhaust PM10 - Total	9,556.24	691.06	646.49
Primary Exhaust PM2.5 - Total	8,791.72	635.77	594.77
Note: The primary exhaust PM10 pollutants listed represent the required/prerequisite pollutants when selecting primary exhaust PM10 in the moves model. The primary exhaust PM10 output from the MOVES model incorporates these pollutants in its modeled total, and they do not need to be individually summed to get PM10 emissions.			

Naphthalene			
Naphthalene gas	286.93	14.68	15.11
Naphthalene particle	0.26	0.04	0.04

Other MSATs			
1,3-Butadiene	304.76	0.00	0.00
Acetaldehyde	1,366.08	157.80	169.48
Acrolein	157.44	11.64	12.33
Benzene	2,858.96	377.42	388.97
Ethyl Benzene	1,476.26	304.90	320.81
Formaldehyde	2,324.46	199.15	210.75

Pollutant Name	i27016inv	i27050nbinv	i27050bldinv
Greenhouse Gases			
Methane (CH4)	17,775.27	9,648.99	8,822.36
Nitrous Oxide (N2O)	2,836.05	1,442.09	1,326.82
Atmospheric CO2	400,027,141.40	340,643,563.88	342,858,925.19
CO2 Equivalent	401,310,428.98	341,311,465.14	343,472,085.24

Appendix D
MSAT Discussion

Mobile Source Air Toxics

Transportation projects may affect the regional or local air toxic concentrations due to the mobile source air toxic (MSAT) emissions from vehicles. Potential MSAT effects from the project operation were evaluated following the Federal Highway Administration (FHWA) memorandum titled *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2016).

1.0 Background

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act (CAA) Amendments of 1990, whereby Congress mandated that the U.S. Environmental Protection Agency (EPA) regulate 188 air toxics, also known as hazardous air pollutants. EPA assessed this expansive list in its latest rule on the Control of Hazardous Air Pollutants From Mobile Sources (*Federal Register*, Vol. 72, No. 37, page 8430, February 26, 2007), and identified a group of 93 compounds emitted from mobile sources that are listed in EPA's Integrated Risk Information System (IRIS) (EPA 2021). In addition, EPA identified nine compounds with significant contributions from mobile sources that are among the national and regional-scale cancer risk drivers or contributors and noncancer hazard contributors from the EPA's *National Air Toxics Assessment* (EPA 2014). These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority MSATs, the list is subject to change and may be adjusted in consideration of future EPA rules.

2.0 Motor Vehicle Emissions Simulator (MOVES)

Using EPA's MOVES2014a model, as shown on Figure D-1, FHWA estimates that even if vehicle miles traveled (VMT) increase by 45 percent from 2010 to 2050 as forecast, a combined reduction of 91 percent in the total annual emissions for the priority MSATs is projected for the same time period. Diesel PM is the dominant component of MSAT emissions, making up 50 to 70 percent of all priority MSAT pollutants by mass, depending on calendar year (FHWA 2016).

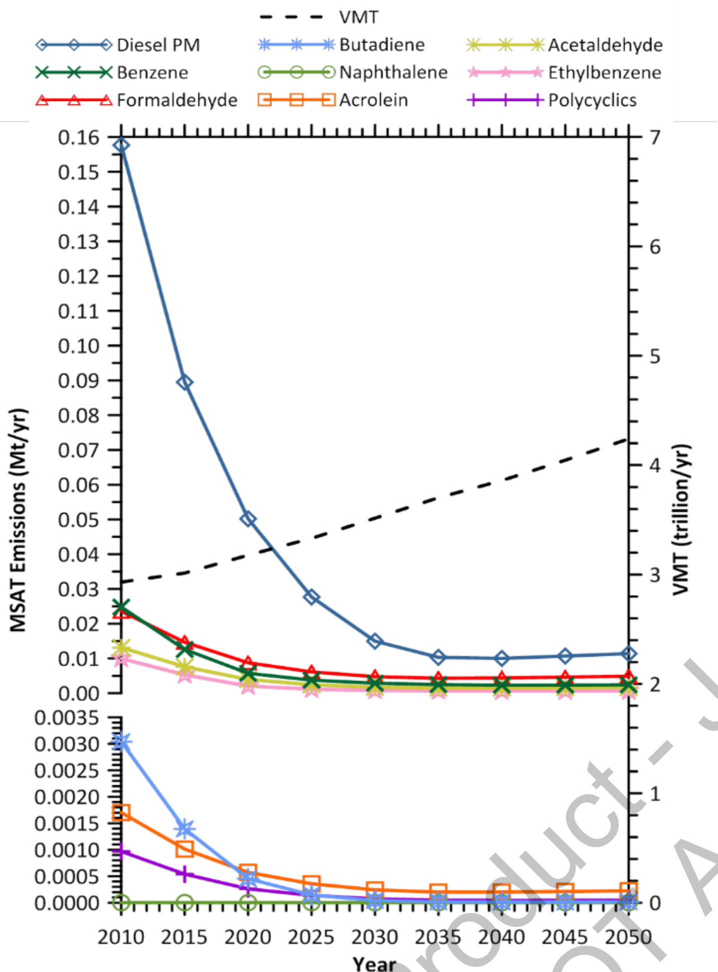

Figure D-1. FHWA Projected National MSAT Emissions Trends 2010 to 2050 for Vehicles operating on Roadways using EPA's MOVES2014a Model

Note: Trends for specific locations may be different, depending on locally derived information representing VMT, vehicle speeds, vehicle mix, fuels, emission control programs, meteorology, and other factors.

Mt = million tons

Source: EPA MOVES2014a model runs conducted by FHWA (FHWA 2016)

3.0 Mobile Source Air Toxic Research

Air toxic analysis is a continuing area of research. While much work has been done to assess the overall health risk of air toxics, many questions remain unanswered. In particular, the tools and techniques for assessing project-specific health outcomes as a result of lifetime MSAT exposure remain limited. These limitations impede the ability to evaluate how the potential health risks posed by MSAT exposure should be factored into project-level decision-making within the context of the National Environmental Policy Act (NEPA).

Nonetheless, air toxic concerns continue to arise on highway projects during the NEPA process. Even as the science emerges, the public and other agencies expect FHWA to address MSAT impacts in environmental documents. FHWA, EPA, the Health Effects Institute (HEI), and others have funded and conducted research studies to try to more clearly define potential risks from MSAT emissions associated with highway projects. FHWA will continue to monitor the developing research in this field.

4.0 Consideration of Mobile Source Air Toxics in NEPA Documents

FHWA developed a tiered approach with three categories for analyzing MSAT impacts, depending on specific project circumstances:

- No analysis for projects with no potential for meaningful MSAT effects
- These projects typically include those qualifying as a categorical exclusion under 23 *Code of Federal Regulations* (CFR) 771.117; projects exempt under the conformity rule under 40 CFR 93.126; or other projects with no meaningful impacts on traffic volumes or vehicle mix.
- Qualitative analysis for projects with low potential MSAT effects
- According to FHWA's updated interim guidance, projects considered to have low potential MSAT effects include those that improve operations of highway, transit, or freight without adding substantial new capacity or without creating a facility that is likely to meaningfully increase MSAT emissions (FHWA 2016).
- Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects
- Examples of these projects include those that will create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of diesel PM in a single location, involving a significant number of diesel vehicles for new projects or accommodating with a significant increase in the number of diesel vehicles for expansion projects; or create new capacity or add significant capacity to urban highways such as interstates, urban arterials, or urban collector-distributor routes with traffic volumes where the average annual daily traffic (AADT) is projected to be in the range of 140,000 to 150,000 or greater by the design year. These types of projects are also located near populated areas.

5.0 Quantitative Analysis of Mobile Source Air Toxic Emissions

The project is located in the populated Denver metropolitan area. Compared with the No Action Alternative, the Proposed Action would increase traffic volumes on Interstate 270 (I-270) due to the additional travel lanes. All segments on I-270 would exceed 140,000 AADT under the Proposed Action. Therefore, this project would have high potential for MSAT effects, and a quantitative analysis of the MSAT emissions was conducted in accordance with FHWA's MSAT guidance (FHWA 2016). Emissions of the nine priority MSATs (1,3-butadiene, acetaldehyde, acrolein, benzene, diesel PM, ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter) in the existing conditions and from the No Action Alternative and Proposed Action in 2050 were modeled using the MOVES3 model, and the results are summarized in Table D-1. Input parameters for the MOVES3 model were the same as those used for the criteria pollutants emission inventory analysis and are detailed in Attachment 3 of the Air Quality Analysis Work Plan (Appendix A).

As shown in Table D-1, the VMT estimated for the Proposed Action is higher than that for the No Action Alternative, because the project would add new travel lanes that would attract additional trips that would not otherwise occur in the study area. Although there is an increase in VMT, MSATs under the Proposed Action would be lower than the No Action Alternative in the study area. In addition, further decreases in MSAT emissions in the study area are likely due to emissions reductions from reduced congestion and increased vehicle speeds. Also, MSAT emissions would be lower in other locations when traffic shifts from existing roadways to the improved I-270.

Table D-1. Daily Mobile Source Air Toxic Emissions for the Study Area

Parameter	Existing Conditions 2016	No Action 2050	Proposed Action 2050
VHT/day	36,186	50,649	49,204
VMT/day	1,393,148	1,606,823	1,942,340
1,3-butadiene (ppd)	0.671	0.000	0.000
Acetaldehyde (ppd)	3.009	0.373	0.348
Acrolein (ppd)	0.347	0.027	0.026
Benzene (ppd)	6.297	0.857	0.831
Diesel PM (tpd)	0.011	0.00076	0.00071
Ethylbenzene (ppd)	3.252	0.707	0.672
Formaldehyde (ppd)	5.120	0.464	0.439
Naphthalene (ppd)	0.632	0.033	0.032
Polycyclic Organic Matter (ppd)	0.276	0.0152	0.0149

Source: Wells, pers. comm. 2022

ppd = pound(s) per day
tpd = ton(s) per day
VHT/day = vehicle hours traveled per day

For both alternatives, 2050 emissions would be lower than present levels as a result of EPA's national emissions control programs that are projected to reduce annual MSAT emissions by 90 percent from 2010 to 2050 (FHWA 2016). Local conditions may differ from these national projections in terms of fleet mix and turnover, VMT growth rates, and local control measures. However, the magnitude of the EPA-projected reductions is so great (even after accounting for VMT growth) that MSAT emissions in the study area would be lower in the future than they are today as shown in Table D-1.

Localized increases in MSAT concentrations could occur where the expanded freeway sections and interchange improvements shift closer to sensitive receptors. This would occur along I-270 between Interstate 76 and York Street to accommodate the connector ramp and at the I-270/York Street interchange and I-270/Vasquez Boulevard interchange.

The magnitude and the duration of any potential increases compared with the No Action Alternative cannot be reliably quantified due to incomplete or unavailable information for forecasting project-specific MSAT health impacts. In summary, when a highway is widened, the localized level of MSAT emissions for the Proposed Action could be higher relative to the No Action Alternative at certain locations, but this could be offset by increases in speeds and reductions in congestion (which are associated with lower MSAT emissions). Also, MSATs would be lower in other locations when traffic shifts away from them. However, on a regional basis, EPA's vehicle and fuel regulations, coupled with fleet turnover, will over time cause substantial reductions that, in almost all cases, will cause regionwide and corresponding localized MSAT levels to be significantly lower than today.

6.0 Incomplete or Unavailable Information for Project-specific Mobile Source Air Toxic Health Impact Analysis

The MSAT analysis of the project includes a basic analysis of the likely MSAT impacts of the proposed project. Due to the limitations of information and methodology of the analysis, the following discussion is included in accordance with Council on Environmental Quality regulations regarding incomplete or unavailable information (40 CFR 1502.22(b)). The discussion regarding the limitations of the MSAT analysis is prototype language taken from Appendix C of the FHWA *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2016).

In FHWA's view, information is incomplete or unavailable to credibly predict the project-specific health impacts due to changes in MSAT emissions associated with a proposed set of highway alternatives. The outcome of such an assessment, adverse or not, would be influenced more by the uncertainty introduced into the process through assumption and speculation rather than any genuine insight into the actual health impacts directly attributable to MSAT exposure associated with a proposed action.

EPA is responsible for protecting the public health and welfare from any known or anticipated effects of an air pollutant. EPA is the lead authority for administering the CAA and its amendments and has specific statutory obligations with respect to hazardous air pollutants and MSATs. EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. It maintains IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (EPA 2021). Each report provides assessments of noncancerous and cancerous effects for individual compounds and quantitative estimates of risk levels from lifetime oral and inhalation exposures with uncertainty spanning perhaps an order of magnitude.

Other organizations are also active in the research and analyses of the human health effects of MSATs, including HEI. A number of HEI studies are summarized in Appendix D of FHWA's *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2016). Among the adverse health effects linked to MSAT compounds at high exposures are cancer in humans in occupational settings, cancer in animals, and irritation to the respiratory tract, including the exacerbation of asthma. Less obvious are the adverse human health effects of MSAT compounds at current environmental concentrations (HEI 2007) or in the future as vehicle emissions substantially decrease.

The methodologies for forecasting health impacts include emissions modeling, dispersion modeling, exposure modeling, and then final determination of health impacts, with each step in the process building on the model predictions obtained in the previous step. All are encumbered by technical shortcomings or uncertain science that prevents a more complete differentiation of the MSAT health impacts among a set of project alternatives. These difficulties are magnified for lifetime (i.e., 70-year) assessments, particularly because unsupportable assumptions would have to be made regarding changes in travel patterns and vehicle technology (which affects emissions rates) over that time frame, since such information is unavailable.

It is particularly difficult to reliably forecast 70-year lifetime MSAT concentrations and exposure near roadways, to determine the portion of time that people are actually exposed at a specific location, and to establish the extent of exposure attributable to a specific proposed action, especially given that some of the information needed is unavailable.

There are considerable uncertainties associated with the existing estimates of toxicity of the various MSATs because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI (HEI 2007). As a result, there is no national consensus on air dose–response values assumed to protect the public health and welfare for MSAT compounds, and in particular for diesel PM. EPA states that with respect to diesel engine exhaust, "[t]he absence of adequate data to develop a sufficiently confident dose-response relationship from the epidemiologic studies has prevented the estimation of inhalation carcinogenic risk" (EPA IRIS database, Diesel Engine Exhaust, Section II.C[1]).

There is also a lack of national consensus on an acceptable level of risk. The current context is the process used by EPA as provided by the CAA to determine whether more-stringent controls are required in order to provide an ample margin of safety to protect public health or to prevent an adverse environmental effect for industrial sources subject to the maximum achievable control technology standards, such as benzene emissions from refineries. The decision framework is a two-step process. The first step requires EPA to determine an "acceptable" level of risk due to emissions from a source, which is generally no greater than approximately 100 in a million. Additional factors are considered in the second step, the goal of which is to maximize the number of people with risks less than one in a million due to emissions from a source. The results of this statutory two-step process do not guarantee that cancer risks from exposure to air toxics are less than one in a million; in some cases, the residual risk determination could result in maximum individual cancer risks that are as high as approximately 100 in a million. In a June 2008 decision, the U.S. Court of Appeals for the District of Columbia Circuit upheld EPA's approach to addressing risk in its two-step decision framework. Information is incomplete or unavailable to establish that even the largest of highway projects would result in levels of risk greater than deemed acceptable.[2]

Because of the limitations in the methodologies for forecasting health impacts described, any predicted difference in health impacts between alternatives is likely to be much smaller than the uncertainties associated with predicting the impacts. Consequently, the results of such assessments would not be useful to decision-makers, who would need to weigh this information against project benefits, such as reducing traffic congestion, accident rates, and fatalities plus improved access for emergency response, that are better suited for quantitative analysis.

7.0 References

Federal Highway Administration (FHWA). 2016. *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*. October 18. https://www.fhwa.dot.gov/environment/air_quality/air_toxics/policy_and_guidance/msat/.

Health Effects Institute (HEI). 2007. *Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects*. Special Report 16. https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects.

U.S. Environmental Protection Agency (EPA). 2014. *National Air Toxics Assessment.* https://www.epa.gov/national-air-toxics-assessment.

U.S. Environmental Protection Agency (EPA). 2021. "Integrated Risk Information System." https://www.epa.gov/iris.

Wells, Dale, APCD. 2022. Personal communication (email) with Dana Ragusa, Jacobs. February 15.

1 https://cfpub.epa.gov/ncea/iris/iris_documents/documents/subst/0642.htm#quainhal

2 https://www.cadc.uscourts.gov/internet/opinions.nsf/284E23FFE079CD59852578000050C9DA/$file/07-1053-1120274.pdf

Appendix E
GHG Discussion

Greenhouse Gases

Human activity is changing the Earth's climate by causing the buildup of heat-trapping greenhouse gas (GHG) emissions through the burning of fossil fuels and other human activities. Carbon dioxide (CO_2) is the largest component of human-produced emissions; other prominent emissions include methane (CH_4), nitrous oxide (N_2O), and hydrofluorocarbons. These emissions are different from criteria air pollutants because their effects in the atmosphere are global rather than local, and also because they remain in the atmosphere for decades to centuries, depending on the species.

GHG emissions have accumulated rapidly as the world has industrialized, with the concentration of atmospheric CO_2 increasing from roughly 300 parts per million (ppm) in 1900 to over 400 ppm today. Over this time frame, global average temperatures have increased by roughly 1.5 degrees Fahrenheit (1 degree Celsius), and the most rapid increases have occurred over the past 50 years. Scientists have warned that significant and potentially dangerous shifts in climate and weather are possible without substantial reductions in GHG emissions. They have commonly cited 2 degrees Celsius (1 degree Celsius beyond warming that has already occurred) as the total amount of warming the Earth can tolerate without serious and potentially irreversible climate effects. For warming to be limited to this level, atmospheric concentrations of CO_2 would need to stabilize at a maximum of 450 ppm, requiring annual global emissions to be reduced 40 to 70 percent below 2010 levels by 2050 (IPCC 2014).

State and national governments in many developed countries have set GHG emissions reduction targets of 80 percent below current levels by 2050, recognizing that post-industrial economies are primarily responsible for GHGs already in the atmosphere. As part of a 2014 bilateral agreement with China, the United States pledged to reduce GHG emissions 26 to 28 percent below 2005 levels by 2025; this emissions reduction pathway is intended to support economy-wide reductions of 80 percent or more by 2050 (The White House 2014).

GHG emissions from vehicles using roads are a function of distance traveled (expressed as vehicle miles traveled [VMT]), vehicle speed, and vehicle type. A major factor in mitigating increases in VMT is the U.S. Environmental Protection Agency's (EPA's) GHG emissions standards, implemented in concert with national fuel economy standards. The U.S. Energy Information Administration projects that vehicle energy efficiency (and thus GHG emissions) on a per-mile basis will improve by 28 percent between 2012 and 2040 (EIA 2016). This improvement in vehicle emissions rates is more than sufficient to offset the increase in VMT.

Construction and subsequent maintenance of the selected project alternative would generate GHG emissions. Preparing the roadway corridor (for example, by earthmoving activities) would involve a considerable amount of energy consumption and resulting GHG emissions; manufacturing of the materials used in construction and fuel used by construction equipment would also contribute GHG emissions. Typically, construction emissions associated with a new road account for about 5 percent of the total 20-year lifetime emissions from the road, although this can vary widely with the extent of construction activity and the number of vehicles that use the road.

The addition of new road-miles to the roadway network in the study area would also increase the energy and GHG emissions associated with maintaining those new road-miles in the future. The increase in maintenance needs as a result of adding new roadway infrastructure would be partially offset by the reduced need for maintenance on existing routes (because of lower total traffic and truck volumes on those routes).

EPA's MOVES3 model was used to estimate vehicle exhaust emissions of CO_2 and other GHGs. CO_2 is frequently used as an indicator of overall transportation GHG emissions because the quantity of these emissions is much larger than that of all other transportation GHGs combined, and because CO_2 accounts for 90 to 95 percent of the overall climate impact from transportation sources.

The MOVES3 model was run to estimate GHG emissions in the study area with the No Action Alternative and Proposed Action. Input parameters for the model were the same as those used for other MOVES3 analyses and are detailed in Attachment 3 of the Air Quality Analysis Work Plan (Appendix A). Table E-1 shows the GHG emissions associated with the project. Total emissions of GHGs are presented as CO_2 equivalent (CO_2e) that were calculated using the global warming potential of each GHG.

Table E-1. Emissions of Greenhouse Gases in the I-270 Corridor Improvements Study Area in 2050

Greenhouse Gas	Existing Conditions Emissions (tpy) 2016	No Action Alternative Emissions (tpy) 2050	Proposed Action Emissions (tpy) 2050	Percent Change from Proposed Action and No Action Alternatives
CH_4	7.145	3.879	3.546	-8.58
N_2O	1.140	0.580	0.533	-8.10
Atmospheric CO_2	160,804	136,933	137,823	+0.65
Total CO_2e	**161,320**	**137,201**	**138,070**	**+0.63**

Source: Wells, pers. comm. 2022

CO_2e = CO_2 equivalent, calculated using the global warming potential of 298 for N_2O and 25 for CH_4 in MOVES3
tpy = ton(s) per year

As shown in Table E-1, total GHG emissions would decrease in 2050 compared with the existing condition for both the No Action Alternative and Proposed Action due to improvements in vehicle emission rates, even with increased VMT in 2050. Modeled GHG emissions for the 2050 Proposed Action are slightly higher (1 percent) compared with the No Action Alternative due to a combination of the effects from increases VMT, reduced congestion, and improved vehicle economy.

To help address the global issue of climate change, U.S. Department of Transportation (USDOT) is committed to reducing GHG emissions from vehicles traveling on highways. USDOT and EPA are working together to reduce these emissions by substantially improving vehicle efficiency standards and moving toward less–carbon-intensive fuels. The agencies have jointly established new, more-stringent fuel economy standards and the first-ever GHG emissions standards for cars and light trucks, which were revised in 2021 for model years 2017 to 2026, with an ultimate real-world fuel economy goal of 40 miles per gallon for cars and light trucks by model year 2026. In addition, on September 15, 2011, the agencies jointly published the first-ever (Phase 1) fuel economy and GHG emissions standards for heavy-duty trucks and buses. In October 2016, the agencies finalized Phase 2 standards for medium- and heavy-duty vehicles through model year 2027. Also, increasing use of technological innovations that can improve fuel economy, such as gasoline- and diesel-electric hybrid vehicles, will improve air quality and reduce CO_2 emissions in future years.

The construction best practices described in Section 6.1 of the *Air Quality Technical Report* are practicable project-level measures that could help reduce GHG emissions incrementally and could contribute in the long term to meaningful cumulative reduction when considered across the Federal-Aid Highway Program.

References

Intergovernmental Panel on Climate Change (IPCC). 2014. *Climate Change 2014 Synthesis Report Summary for Policymakers*. Contribution of Working Groups I, II, and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. http://www.ipcc.ch/pdf/assessment-report/ar5/syr/AR5_SYR_FINAL_SPM.pdf.

U.S. Energy Information Administration (EIA). 2016. *International Energy Outlook 2016*. DOE/EIA-0484(2016). May.

Wells, Dale, APCD. 2022. Personal communication (email) with Dana Ragusa, Jacobs. February 15.

The White House, Office of the Press Secretary (The White House). 2014. "U.S.–China Joint Announcement on Climate Change." November 11.

Appendix F
CO Analysis Screening and Results

Table F-1. 2050 Signalized Intersection Data

Intersection	Control Type	Existing						No Action Alternative						Proposed Action Alternative					
		a.m. Peak			p.m. Peak			a.m. Peak			p.m. Peak			a.m. Peak			p.m. Peak		
		Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume	Avg. Control Delay	LOS	Volume
Quebec St./ Sandcreek Dr. South	Signal	53.6	D	4,102	**73.1**	**E**	**4,861**	25.8	C	3,529	25.5	C	3,583	28.8	C	4,450	33.3	C	4,211
Quebec St./ I-270 WB On-Ramp	Signal	58.1	E	3,659	32.9	C	4,400	10.1	A	3,139	16.1	B	3,101	14.0	B	4,120	13.6	B	3,808
Vasquez Blvd./ E 56th Ave.	Signal	28	C	4,073	**119.5**	**F**	**4,919**	**300.7**	**F**	**6,186**	**198.1**	**F**	**7,606**	**112.5**	**F**	**6,056**	**127.4**	**F**	**7,250**
Vasquez Blvd./ E 60th Ave.	Signal	36.3	D	3,040	45.1	D	**4,461**	66.1	E	5,193	**147.7**	**F**	**6,834**	36.3	D	4,982	95.3	F	**6,374**
York St./ I-270 EB Ramp	Signal [a]	24.6	C	1,355	29.1	C	1,251	13.3	B	1,933	124.0	F	2,281	18.6	B	2,296	**170.5**	**F**	2,496
York St./ I-270 WB On-Ramp	Signal	58	E	1,760	**64.3**	**E**	1,570	9.7	A	2,061	7.8	A	2,224	14.1	B	2,431	8.1	A	2,380
Vasquez Blvd./ I-270 EB Off-Ramp	Signal [b]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	6.0	A	4,967	4.5	A	5,847
Vasquez Blvd./ I-270 WB Off-Ramp	Signal [b]	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	n/a	1.2	A	3,725	6.2	A	4,752

[a] Stop control under existing

[b] New intersection under Proposed Action

Note:

Bold is top three delay and top three highest volume.

Ave. = Avenue
Avg. = Average
Blvd. = Boulevard
Dr. = Drive
EB = eastbound
I-270 = Interstate 270
LOS = level of service
n/a = not applicable
St. = Street
WB = westbound

Movement	EBL	EBT	EBR	WBL	WBT	WBR	NBL	NBT	NBR	SBL	SBT	SBR
Lane Configurations												
Traffic Volume (vph)	280	95	92	487	256	468	25	2673	8	407	2365	94
Future Volume (vph)	280	95	92	487	256	468	25	2673	8	407	2365	94
Ideal Flow (vphpl)	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900	1900
Total Lost time (s)	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Lane Util. Factor	0.91	0.91		0.91	0.91	1.00	1.00	0.86	1.00	1.00	0.86	
Frt	1.00	0.96		1.00	1.00	0.85	1.00	1.00	0.85	1.00	0.99	
Flt Protected	0.95	0.98		0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (prot)	1610	3176		1610	3309	1583	1770	6408	1583	1770	6371	
Flt Permitted	0.95	0.98		0.95	0.98	1.00	0.95	1.00	1.00	0.95	1.00	
Satd. Flow (perm)	1610	3176		1610	3309	1583	1770	6408	1583	1770	6371	
Peak-hour factor, PHF	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92	0.92
Adj. Flow (vph)	304	103	100	529	278	509	27	2905	9	442	2571	102
RTOR Reduction (vph)	0	22	0	0	0	253	0	0	6	0	2	0
Lane Group Flow (vph)	170	315	0	264	543	256	27	2905	3	442	2671	0
Turn Type	Split	NA		Split	NA	Perm	Prot	NA	Perm	Prot	NA	
Protected Phases	4	4		8	8		5	2		1	6	
Permitted Phases						8			2			
Actuated Green, G (s)	24.8	24.8		37.6	37.6	37.6	7.2	59.4	59.4	38.2	90.4	
Effective Green, g (s)	24.8	24.8		37.6	37.6	37.6	7.2	59.4	59.4	38.2	90.4	
Actuated g/C Ratio	0.14	0.14		0.21	0.21	0.21	0.04	0.33	0.33	0.21	0.50	
Clearance Time (s)	5.0	5.0		5.0	5.0	5.0	5.0	5.0	5.0	5.0	5.0	
Vehicle Extension (s)	3.0	3.0		3.0	3.0	3.0	3.0	3.0	3.0	3.0	3.0	
Lane Grp Cap (vph)	221	437		336	691	330	70	2114	522	375	3199	
v/s Ratio Prot	c0.11	0.10		0.16	c0.16		0.02	c0.45		c0.25	0.42	
v/s Ratio Perm						0.16			0.00			
v/c Ratio	0.77	0.72		0.79	0.79	0.78	0.39	1.37	0.01	1.18	0.83	
Uniform Delay, d1	74.8	74.3		67.4	67.4	67.2	84.2	60.3	40.5	70.9	38.4	
Progression Factor	1.00	1.00		1.00	1.00	1.00	1.00	1.00	1.00	1.00	1.00	
Incremental Delay, d2	14.8	5.6		11.4	5.9	10.8	3.5	171.4	0.0	104.7	2.0	
Delay (s)	89.7	79.9		78.8	73.3	78.1	87.8	231.7	40.5	175.6	40.4	
Level of Service	F	E		E	E	E	F	F	D	F	D	
Approach Delay (s)		83.2			76.2			229.8			59.6	
Approach LOS		F			E			F			E	

Intersection Summary			
HCM 2000 Control Delay	127.4	HCM 2000 Level of Service	F
HCM 2000 Volume to Capacity ratio	1.09		
Actuated Cycle Length (s)	180.0	Sum of lost time (s)	20.0
Intersection Capacity Utilization	101.2%	ICU Level of Service	G
Analysis Period (min)	15		

c Critical Lane Group

```
'Vas 56 PM PA'   60.00 127.000 0.00 0.00 20 0.3048 1 1
'R1'                                64         52        5.9
'R2'                               146         52        5.9
'R3'                               228         52        5.9
'R4'                                64        134        5.9
'R5'                                64        216        5.9
'R6'                               -64         40        5.9
'R7'                              -146         40        5.9
'R8'                              -228         40        5.9
'R9'                               -64        122        5.9
'R10'                              -64        204        5.9
'R11'                              -64        -40        5.9
'R12'                             -146        -40        5.9
'R13'                             -228        -40        5.9
'R14'                              -64       -122        5.9
'R15'                              -64       -204        5.9
'R16'                               76        -40        5.9
'R17'                              158        -40        5.9
'R18'                              240        -40        5.9
'R19'                               76       -122        5.9
'R20'                               76       -204        5.9
'Vas 56 PM PA'                                 18          1          1       'C'
                           2
  -2
'56EBL'                     'AG'           -54.00       0.00    -554.00       0.00
0.00        12          1
                         180        155      2.00        280       4.86       1610
   2         3
                           2
'56EBT'                     'AG'           -54.00     -18.00    -554.00     -18.00
0.00        24          2
                         180        155      2.00        187       4.86       1588
   2         3
                           2
'56WBL'                     'AG'            54.00       0.00     554.00       0.00
0.00        12          1
                         180        142      2.00        487       4.86       1610
   2         3
                           2
'56WBT'                     'AG'            54.00      18.00     554.00      18.00
0.00        24          2
                         180        142      2.00        256       4.86       1655
   2         3
                           2
'56WBR'                     'AG'            54.00      36.00     554.00      36.00
0.00        12          1
                         180        142      2.00        468       4.86       1583
   2         3
                           2
'VasNBL'                    'AG'             0.00     -30.00       0.00    -530.00
```

```
0.00        12          1
                          180       173       2.00         25       4.86       1770
   2         3
                           2
'VasNBT'                    'AG'             30.00     -30.00      30.00    -530.00
0.00        48          4
                          180       121       2.00       2681       4.86       1602
   2         3
                           2
'VasNBR'                    'AG'             60.00     -30.00      60.00    -530.00
0.00        12          1
                          180       121       2.00          8       4.86       1583
   2         3
                           2
'VasSBL'                    'AG'              0.00      30.00       0.00     530.00
0.00        12          1
                          180       142       2.00        407       4.86       1770
   2         3
                           2
'VasSBT'                    'AG'            -30.00      30.00     -30.00     530.00
0.00        48          4
                          180        90       2.00       2459       4.86       1593
   2         3
                           1
'56EBA'                     'AG'          -1000.00     -18.00       0.00     -18.00
467.00      4.86       0.00   44.00
                           1
'56EBD'                     'AG'              0.00     -18.00    1000.00     -18.00
510.00      4.86       0.00   44.00
                           1
'56WBA'                     'AG'           1000.00      18.00       0.00      18.00
1211.00      4.86       0.00   44.00
                           1
'56WBD'                     'AG'              0.00      18.00   -1000.00      18.00
375.00      4.86       0.00   44.00
                           1
'VasNBA'                    'AG'             30.00   -1000.00      30.00       0.00
2706.00      3.66       0.00   68.00
                           1
'VasNBD'                    'AG'             30.00       0.00      30.00    1000.00
3421.00      3.66       0.00   68.00
                           1
'VasSBA'                    'AG'            -30.00    1000.00     -30.00       0.00
2866.00      3.66       0.00   68.00
                           1
'VasSBD'                    'AG'            -30.00       0.00     -30.00   -1000.00
2944.00      3.66       0.00   68.00
1.00 0 5 1000 0 'y' 10 0 35
```

```
                          CAL3QHC: LINE SOURCE DISPERSION MODEL - VERSION 2.0 Dated
95221                        PAGE  1

      JOB: Vas 56 PM PA                                          RUN: Vas 56 PM PA


      DATE :  8/18/21
      TIME :  8:32:15

         The MODE flag has been set to C for calculating CO averages.

       SITE & METEOROLOGICAL VARIABLES
       -------------------------------
       VS =   0.0 CM/S       VD =   0.0 CM/S       Z0 = 127. CM
        U =  1.0 M/S         CLAS =   5  (E)     ATIM =  60. MINUTES     MIXH =
1000. M   AMB =  0.0 PPM  BRG =   0. DEGREES

       LINK VARIABLES
       --------------
         LINK DESCRIPTION     *         LINK COORDINATES (FT)          *    LENGTH
BRG TYPE   VPH    EF      H   W    V/C QUEUE
                              *   X1        Y1        X2        Y2     *     (FT)
(DEG)            (G/MI)  (FT) (FT)      (VEH)

------------------------*-----------------------------------------*-----------------
-----------------------------------------
       1. 56EBL               *   -54.0       0.0   -1273.3       0.0 *    1219.
270. AG     11. 100.0   0.0 12.0 1.50  61.9
       2. 56EBT               *   -54.0     -18.0    -132.8     -18.0 *      79.
270. AG     22. 100.0   0.0 24.0 0.50   4.0
       3. 56WBL               *    54.0       0.0    2319.8       0.0 *    2266.
 90. AG     10. 100.0   0.0 12.0 1.60 115.1
       4. 56WBT               *    54.0      18.0     153.4      18.0 *      99.
 90. AG     21. 100.0   0.0 24.0 0.41   5.0
       5. 56WBR               *    54.0      36.0    2164.8      36.0 *    2111.
 90. AG     10. 100.0   0.0 12.0 1.57 107.2
       6. VasNBL              *     0.0     -30.0       0.0     -62.7 *      33.
180. AG     13. 100.0   0.0 12.0 0.86   1.7
       7. VasNBT              *    30.0     -30.0      30.0   -2346.0 *    2316.
180. AG     35. 100.0   0.0 48.0 1.37 117.7
       8. VasNBR              *    60.0     -30.0      60.0     -35.3 *       5.
180. AG      9. 100.0   0.0 12.0 0.02   0.3
       9. VasSBL              *     0.0      30.0       0.0    1132.3 *    1102.
360. AG     10. 100.0   0.0 12.0 1.22  56.0
      10. VasSBT              *   -30.0      30.0     -30.0     332.2 *     302.
360. AG     26. 100.0   0.0 48.0 0.81  15.4
      11. 56EBA               *  -1000.0    -18.0       0.0     -18.0 *    1000.
 90. AG    467.   4.9   0.0 44.0
      12. 56EBD               *     0.0     -18.0    1000.0     -18.0 *    1000.
 90. AG    510.   4.9   0.0 44.0
```

```
      13. 56WBA               *   1000.0      18.0       0.0      18.0 *    1000.
270. AG   1211.   4.9   0.0 44.0
      14. 56WBD               *      0.0      18.0   -1000.0      18.0 *    1000.
270. AG    375.   4.9   0.0 44.0
      15. VasNBA              *     30.0   -1000.0      30.0       0.0 *    1000.
360. AG   2706.   3.7   0.0 68.0
      16. VasNBD              *     30.0       0.0      30.0    1000.0 *    1000.
360. AG   3421.   3.7   0.0 68.0
      17. VasSBA              *    -30.0    1000.0     -30.0       0.0 *    1000.
180. AG   2866.   3.7   0.0 68.0
      18. VasSBD              *    -30.0       0.0     -30.0   -1000.0 *    1000.
180. AG   2944.   3.7   0.0 68.0
```

PAGE 2

JOB: Vas 56 PM PA RUN: Vas 56 PM PA

DATE : 8/18/21
TIME : 8:32:15

```
       ADDITIONAL QUEUE LINK PARAMETERS
       --------------------------------
         LINK DESCRIPTION     *    CYCLE    RED     CLEARANCE  APPROACH  SATURATION
  IDLE   SIGNAL   ARRIVAL
                              *    LENGTH   TIME    LOST TIME    VOL     FLOW RATE
 EM FAC   TYPE     RATE
                              *    (SEC)   (SEC)     (SEC)      (VPH)      (VPH)
(gm/hr)

------------------------*-----------------------------------------------------------
----------------------
       1. 56EBL               *     180      155       2.0        280       1610
  4.86      2        3
       2. 56EBT               *     180      155       2.0        187       1588
  4.86      2        3
       3. 56WBL               *     180      142       2.0        487       1610
  4.86      2        3
       4. 56WBT               *     180      142       2.0        256       1655
  4.86      2        3
       5. 56WBR               *     180      142       2.0        468       1583
  4.86      2        3
       6. VasNBL              *     180      173       2.0         25       1770
  4.86      2        3
       7. VasNBT              *     180      121       2.0       2681       1602
  4.86      2        3
       8. VasNBR              *     180      121       2.0          8       1583
  4.86      2        3
       9. VasSBL              *     180      142       2.0        407       1770
  4.86      2        3
      10. VasSBT              *     180       90       2.0       2459       1593
```

4.86 2 3

RECEPTOR LOCATIONS

RECEPTOR	X (FT)	Y (FT)	Z (FT)
1. R1	64.0	52.0	5.9
2. R2	146.0	52.0	5.9
3. R3	228.0	52.0	5.9
4. R4	64.0	134.0	5.9
5. R5	64.0	216.0	5.9
6. R6	-64.0	40.0	5.9
7. R7	-146.0	40.0	5.9
8. R8	-228.0	40.0	5.9
9. R9	-64.0	122.0	5.9
10. R10	-64.0	204.0	5.9
11. R11	-64.0	-40.0	5.9
12. R12	-146.0	-40.0	5.9
13. R13	-228.0	-40.0	5.9
14. R14	-64.0	-122.0	5.9
15. R15	-64.0	-204.0	5.9
16. R16	76.0	-40.0	5.9
17. R17	158.0	-40.0	5.9
18. R18	240.0	-40.0	5.9
19. R19	76.0	-122.0	5.9
20. R20	76.0	-204.0	5.9

MODEL RESULTS

REMARKS : In search of the angle corresponding to the maximum concentration, only the first angle, of the angles with same maximum concentrations, is indicated as maximum.

WIND ANGLE RANGE: 0.-350.

WIND ANGLE (DEGR) * CONCENTRATION (PPM)

WIND ANGLE (DEGR)	REC1	REC2	REC3	REC4	REC5	REC6	REC7	REC8	REC9	REC10	REC11	REC12	REC13	REC14	REC15	REC16	REC17	REC18	REC19	REC20
0.	0.8	0.1	0.0	0.7	0.7	0.8	0.1	0.0	0.6	0.6	1.0	0.2								

```
0.1   0.7   0.8   0.7   0.3   0.2   0.6   0.6
  10.  *   0.3   0.0   0.0   0.3   0.2   1.1   0.3   0.2   1.1   1.1   1.3   0.4
0.3   1.1   1.0   0.3   0.2   0.2   0.2   0.2
  20.  *   0.1   0.0   0.0   0.1   0.1   1.0   0.4   0.2   1.0   1.0   1.1   0.5
0.4   0.9   0.9   0.2   0.2   0.2   0.1   0.1
  30.  *   0.0   0.0   0.0   0.0   0.0   0.9   0.4   0.3   0.9   0.9   0.9   0.5
0.5   0.9   0.8   0.2   0.2   0.2   0.1   0.1
  40.  *   0.0   0.0   0.0   0.0   0.0   0.8   0.4   0.2   0.8   0.8   0.8   0.5
0.3   0.7   0.8   0.2   0.2   0.2   0.1   0.1
  50.  *   0.0   0.0   0.0   0.0   0.0   0.7   0.4   0.2   0.7   0.7   0.8   0.6
0.3   0.7   0.8   0.3   0.3   0.3   0.1   0.1
  60.  *   0.0   0.0   0.0   0.0   0.0   0.6   0.4   0.2   0.6   0.6   0.8   0.4
0.3   0.7   0.7   0.3   0.3   0.3   0.1   0.1
  70.  *   0.0   0.0   0.0   0.0   0.0   0.6   0.4   0.2   0.6   0.6   0.9   0.6
0.4   0.8   0.7   0.4   0.4   0.4   0.2   0.1
  80.  *   0.1   0.1   0.1   0.0   0.0   0.7   0.5   0.3   0.6   0.6   0.9   0.8
0.5   0.8   0.6   0.4   0.4   0.4   0.1   0.0
  90.  *   0.3   0.3   0.3   0.0   0.0   1.0   0.6   0.4   0.7   0.6   0.8   0.6
0.5   0.6   0.6   0.3   0.3   0.3   0.0   0.0
 100.  *   0.5   0.5   0.5   0.1   0.0   1.1   0.6   0.7   0.7   0.7   0.6   0.3
0.2   0.6   0.6   0.1   0.1   0.1   0.0   0.0
 110.  *   0.4   0.4   0.4   0.1   0.1   0.9   0.5   0.4   0.7   0.7   0.6   0.3
0.2   0.6   0.6   0.0   0.0   0.0   0.0   0.0
 120.  *   0.4   0.3   0.3   0.1   0.1   0.8   0.4   0.4   0.7   0.7   0.6   0.3
0.2   0.6   0.6   0.0   0.0   0.0   0.0   0.0
 130.  *   0.4   0.3   0.3   0.1   0.1   0.7   0.5   0.4   0.7   0.8   0.7   0.3
0.2   0.7   0.7   0.0   0.0   0.0   0.0   0.0
 140.  *   0.4   0.3   0.3   0.1   0.1   0.8   0.5   0.4   0.9   0.8   0.7   0.3
0.2   0.7   0.7   0.0   0.0   0.0   0.0   0.0
 150.  *   0.4   0.3   0.3   0.1   0.1   0.9   0.7   0.5   0.9   0.9   0.8   0.5
0.3   0.8   0.8   0.0   0.0   0.0   0.0   0.0
 160.  *   0.3   0.2   0.2   0.2   0.2   1.1   0.7   0.5   1.0   1.1   1.0   0.5
0.3   1.0   1.0   0.0   0.0   0.0   0.0   0.0
 170.  *   0.4   0.2   0.2   0.3   0.4   1.2   0.5   0.2   1.0   1.2   1.0   0.4
0.1   1.0   1.0   0.1   0.0   0.0   0.1   0.1
 180.  *   1.0   0.3   0.2   0.9   0.9   0.9   0.2   0.1   0.7   0.8   0.8   0.1
0.0   0.8   0.7   0.5   0.1   0.0   0.5   0.5
 190.  *   1.4   0.6   0.5   1.2   1.1   0.4   0.1   0.1   0.2   0.2   0.2   0.0
0.0   0.2   0.2   0.9   0.4   0.2   0.9   0.9
 200.  *   1.2   0.8   0.5   1.0   1.0   0.2   0.2   0.2   0.0   0.1   0.1   0.0
0.0   0.1   0.1   0.8   0.5   0.3   0.8   0.8
 210.  *   0.9   0.8   0.5   0.8   0.8   0.2   0.2   0.2   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.7   0.5   0.2   0.7   0.7
 220.  *   0.8   0.8   0.5   0.8   0.7   0.2   0.2   0.2   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.6   0.4   0.2   0.6   0.6
 230.  *   0.9   0.6   0.5   0.6   0.6   0.2   0.2   0.2   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.6   0.4   0.2   0.6   0.6
 240.  *   0.8   0.6   0.5   0.6   0.6   0.2   0.2   0.2   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.6   0.4   0.2   0.6   0.6
 250.  *   0.9   0.5   0.4   0.5   0.5   0.2   0.2   0.2   0.0   0.0   0.0   0.0
```

```
0.0   0.0   0.0   0.6   0.3   0.2   0.6   0.6
 260.  *   0.8   0.6   0.5   0.6   0.6   0.2   0.2   0.2   0.0   0.0   0.1   0.1
0.1   0.0   0.0   0.6   0.2   0.2   0.6   0.6
 270.  *   0.7   0.5   0.3   0.6   0.6   0.1   0.1   0.1   0.0   0.0   0.1   0.1
0.1   0.0   0.0   0.8   0.4   0.4   0.6   0.6
 280.  *   0.6   0.3   0.2   0.6   0.6   0.0   0.0   0.0   0.0   0.0   0.3   0.3
0.3   0.0   0.0   0.7   0.7   0.6   0.6   0.6
 290.  *   0.6   0.3   0.2   0.6   0.6   0.0   0.0   0.0   0.0   0.0   0.3   0.2
0.2   0.1   0.0   0.7   0.5   0.4   0.6   0.5
 300.  *   0.6   0.3   0.2   0.6   0.6   0.0   0.0   0.0   0.0   0.0   0.3   0.2
0.2   0.0   0.0   0.6   0.5   0.5   0.6   0.6
 310.  *   0.6   0.3   0.3   0.6   0.6   0.0   0.0   0.0   0.0   0.0   0.2   0.1
0.1   0.0   0.0   0.8   0.5   0.6   0.6   0.6
 320.  *   0.8   0.4   0.3   0.7   0.7   0.0   0.0   0.0   0.0   0.0   0.2   0.1
0.1   0.0   0.0   0.8   0.5   0.5   0.6   0.6
 330.  *   0.8   0.5   0.3   0.7   0.7   0.0   0.0   0.0   0.0   0.0   0.2   0.1
0.1   0.0   0.0   0.8   0.6   0.5   0.7   0.6
 340.  *   1.0   0.5   0.3   1.0   1.0   0.1   0.0   0.0   0.1   0.1   0.2   0.1
0.1   0.0   0.1   1.1   0.7   0.5   0.9   0.9
 350.  *   1.0   0.3   0.1   1.0   1.0   0.2   0.0   0.0   0.2   0.2   0.5   0.1
0.1   0.2   0.2   1.0   0.5   0.3   0.9   0.9
 THE HIGHEST CONCENTRATION OF    1.40 PPM OCCURRED AT RECEPTOR REC1 .
```



```
      JOB: Vas 56 PM PA                                          RUN: Vas 56 PM PA


      DATE :  8/18/21
      TIME :  8:32:15


      RECEPTOR - LINK MATRIX FOR THE ANGLE PRODUCING
      THE MAXIMUM CONCENTRATION FOR EACH RECEPTOR

          *    CO/LINK  (PPM)
          *    ANGLE (DEGREES)
          *  REC1  REC2  REC3  REC4  REC5  REC6  REC7  REC8  REC9  REC10 REC11
REC12 REC13 REC14 REC15 REC16 REC17 REC18 REC19 REC20
   LINK # *   190   200   100   190   190   170   150   100    10   170    10    80
   30    10    10   340   280   280   340   340

-------*------------------------------------------------------------------------------
---------------------------------------------
       1  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       2  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       3  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
  0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
       4  *   0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
```

```
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     5  *   0.0   0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     6  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     7  *   0.2   0.1   0.0   0.1   0.1   0.1   0.1   0.0   0.0   0.1   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1
     8  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
     9  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0
    10  *   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.0
0.0   0.1   0.0   0.0   0.0   0.0   0.0   0.0
    11  *   0.0   0.0   0.0   0.0   0.0   0.0   0.1   0.0   0.0   0.0   0.1   0.1
0.1   0.0   0.0   0.0   0.1   0.0   0.0   0.0
    12  *   0.0   0.0   0.1   0.0   0.0   0.0   0.0   0.1   0.0   0.0   0.0   0.1
0.0   0.0   0.0   0.1   0.1   0.2   0.0   0.0
    13  *   0.2   0.2   0.3   0.1   0.0   0.0   0.0   0.1   0.0   0.0   0.0   0.2
0.0   0.0   0.0   0.1   0.0   0.1   0.1   0.0
    14  *   0.0   0.0   0.0   0.0   0.0   0.1   0.1   0.1   0.0   0.0   0.0   0.0
0.0   0.0   0.0   0.0   0.1   0.0   0.0   0.0
    15  *   0.5   0.2   0.0   0.3   0.2   0.2   0.2   0.1   0.0   0.2   0.0   0.1
0.0   0.0   0.0   0.1   0.1   0.1   0.3   0.4
    16  *   0.2   0.0   0.0   0.4   0.6   0.0   0.0   0.1   0.3   0.0   0.3   0.1
0.2   0.3   0.3   0.5   0.1   0.1   0.3   0.1
    17  *   0.0   0.0   0.0   0.0   0.0   0.2   0.0   0.1   0.7   0.5   0.5   0.0
0.2   0.4   0.2   0.3   0.1   0.1   0.2   0.2
    18  *   0.3   0.2   0.0   0.3   0.2   0.6   0.2   0.1   0.0   0.3   0.2   0.1
0.0   0.3   0.5   0.0   0.1   0.0   0.0   0.1
```

Appendix G
PM Work Plan

Air Quality Particulate Matter Modeling Work Plan – Revised August 18, 2022

I-270 Corridor Improvements

1.0 Introduction

This air quality particulate matter (PM) modeling work plan outlines the purpose and methodology for the PM modeling analysis for the Interstate 270 (I-270) Corridor Improvements project proposed by the Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA), in conjunction with local partners Adams County and Commerce City. The project, which includes improvements to approximately 6.5 miles of I-270 in Adams County, Commerce City, and the City and County of Denver, Colorado, between Interstate 25 (I-25) and Interstate 70 (I-70) is described in Sections 1 and 2 of the Environmental Assessment (EA) and EA Appendix B. The PM modeling analysis includes modeling of PM with diameter equal to or less than 2.5 micrometers ($PM_{2.5}$) and PM with diameter equal to or less than 10 micrometers (PM_{10}).

2.0 Methodology for the Air Quality Particulate Modeling Analysis

The $PM_{2.5}$ and PM_{10} air quality modeling analysis will be completed based on the requirements of the National Environmental Policy Act (NEPA), EPA guidance for these types of analyses, and the CDOT Air Quality Project-Level Analysis Guidance (AQ-PLAG), Version 1 (CDOT 2019). The analysis will be performed for the Proposed Action scenario and the No Action scenario, if necessary, for the horizon year of 2050.

PM hot-spot analyses under transportation conformity are required for projects of air quality concern (POAQC). Based on the traffic data for this project, FHWA, in consultation with CDOT, EPA, and the Colorado Air Pollution Control Division (APCD), determined that the project is not a POAQC. Although the project is not a POAQC and a hot-spot analysis for transportation conformity purposes is not required, the air quality particulate modeling analysis will be informed by EPA's *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (EPA 2021), and consistent with the CDOT AQ-PLAG. The analysis will include a summary of the emissions and modeled concentrations of project $PM_{2.5}$ and PM_{10}. It will also include an analysis of design concentrations (previously referred to as design values in earlier versions of the EPA guidance for quantitative PM hot-spot analyses) for the Proposed Action scenario in comparison to the $PM_{2.5}$ and PM_{10} National Ambient Air Quality Standards (NAAQS) and for the No Action scenario if design concentrations in the Proposed Action exceed the NAAQS. Section 3 summarizes the MOVES3 (version 3.0.3) emissions modeling that will be performed for the analysis. In addition, the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) air quality dispersion model (version 21112) will be used to assess potential air quality impacts of $PM_{2.5}$ and PM_{10} emissions from vehicle travel in the study area as described in Section 4. The approach for analyzing the modeling outputs is summarized in Section 5.

3.0 MOVES Modeling for Particulate Matter Emission Factors and Emission Rates

On January 7, 2021, EPA announced in the *Federal Register* the official release of the latest version of its Motor Vehicle Emission Simulator (MOVES), MOVES3, for emissions inventories in state implementation plans (SIPs) and transportation conformity. This announcement started a 2-year grace period for use of MOVES3 in transportation conformity analyses that ends on January 9, 2023. Through the interagency consultation process, MOVES3 was selected for modeling emissions.

MOVES3 runs will be performed, using version 3.0.3, to produce emission factor lookup tables for developing link-specific emission estimates for this project. The lookup tables will be provided to CDOT and FHWA for review before calculating the emission rates for the AERMOD dispersion modeling. The following sub-sections summarize steps for MOVES modeling of $PM_{2.5}$ and PM_{10} emission factors to develop project emissions and complete project-level PM dispersion modeling.

3.1 MOVES Runs – Overview of Approach

MOVES will be run at the Project Scale to model running exhaust, crankcase running exhaust, brake wear, and tire wear $PM_{2.5}$ and PM_{10} emissions. The MOVES runs will produce emission factor lookup tables for developing link-specific emission estimates for this project. Data for Links and Link Source Types will be developed based on roadway link-level traffic data and other MOVES input data provided by APCD and CDOT. MOVES model inputs are discussed in more detail below.

The roadway segments of the I-270 project will be modeled as urban restricted roadways. Other non-freeway roadways will be modeled as urban unrestricted roadways. Only on-road links will be modeled (no “off-network” links will be modeled). For each of the two road types, a series of hypothetical links with traffic volume of 1 vehicle per hour traveling one mile will be created, with average vehicle speed ranging from 0 miles per hour (mph) to 75 mph, and road grade ranging from 0% to 6% and -6%.

To capture the emissions scenarios outlined in EPA’s PM hot-spot guidance, one set of these MOVES runs will be completed for each of three seasons, with appropriate fuels inputs for each season. (Over the course of a year, there are only three possible combinations of gasoline and diesel fuel sold in the Denver metro area, so only three “fuel seasons” need to be modeled to capture the range of fuels.) Since all fuel seasons are being modeled, the MOVES runs will capture the fuel season that would result in the highest PM emissions, as recommended by the hot-spot guidance. Runs to represent different months or times of day will not be needed, because MOVES PM running exhaust, brake wear, and tire wear emissions are not affected by temperature or humidity. Emissions estimates will be developed for both light-duty and heavy-duty (truck and bus) vehicle categories, with appropriate mapping of MOVES source types to truck and non-truck categories based on the available activity data. This results in a total of six MOVES runs to develop a complete set of emissions estimates for all seasons and vehicle types.

This approach is structurally different than the approach outlined in the PM hot-spot guidance, but results in the same emissions calculations. The guidance approach is designed to minimize the number of necessary MOVES runs and assumes that modelers will use project-specific traffic data as part of the MOVES inputs. For the I-270 project, where MOVES is used to generate project-scale lookup tables, there is no need to model multiple time periods during the day in MOVES to capture changes in traffic volumes, speeds or car/truck mix; instead, these factors are incorporated when the MOVES lookup table emissions rates are applied to link-level traffic data outside of MOVES in order to calculate link emissions. The project traffic data are available for four time periods during the day, and the modeled MOVES rates (by vehicle type, speed and grade) will be applied to these four sets of traffic data to calculate emissions for each link by time period. Thus, in this approach there is no need to run MOVES for different time periods to capture traffic changes, and as noted above and in EPA’s guidance, there is also no need to model different time periods during the day to capture changes in temperature and humidity. In this framework, the modeled MOVES rates by season are valid for any time period of the day. This approach for using MOVES has been selected for the flexibility it offers; if traffic data change, or if new links are added to the analysis (which has already occurred for this project, in response to public input), updated link-level emissions can be calculated without the need to revise MOVES inputs and re-run the MOVES model.

Calendar year 2050 will be modeled for the analysis. This represents the year of highest emissions in the project corridor, because it will be the year with the highest VMT. Tailpipe exhaust emissions of PM decline over time, even with rising VMT, due to EPA regulations controlling these emissions; however, brake wear, tire wear, and road dust emissions all increase in direct proportion to VMT, and these sources contribute the bulk of PM emissions from on-road vehicles.

3.2 Run Specification Inputs

RunSpecs will be created to define the parameters of the MOVES model. **Table 1** summarizes the MOVES inputs for the RunSpec as defined in the navigation panel of the MOVES interface. The following subsections describe input options needed for the RunSpec.

Table 1. MOVES RunSpec Options

Navigation Panel	Model Selection
Scale	Project scale; inventory calculation type
Time Spans	Hour; weekdays; January/April/July (representing the three fuel seasons) calendar year 2050
Geographic Bounds	Adams County
Vehicles	All MOVES3 vehicle and fuel type combinations
Road Types	Urban restricted access, urban unrestricted access
Pollutants and Processes	$PM_{2.5}$ and PM_{10}; running exhaust and crankcase running exhaust, brake wear, tire wear
General Output	Units of grams and miles
Output Emissions Detail	Road type

3.3 Project Data Manager

After the RunSpec is created, an input database table must be created before running MOVES. This is done using the Project Data Manager to enter project-specific data. **Table 2** summarizes the MOVES Project Data Manager inputs, and they are discussed in more detail below. All proposed MOVES Project Data Manager inputs will be provided to CDOT and FHWA for their review prior to their use in MOVES runs.

Table 2. MOVES Project Data Manager Inputs

Project Data Manager Tab	Data Source
Meteorology Data	APCD Provided Data
Age Distribution	APCD Provided Data
Fuel	MOVES default
Retrofit	No inputs (N/A)
I/M Program	APCD Provided Data
Link Source Type	APCD Provided Data
Links	Generated by Sonoma Technology

3.3.1 Meteorology Data

As noted above, the MOVES PM running exhaust, brake wear, and tire wear emissions are not affected by meteorological inputs (temperature and humidity). Nevertheless, some data must be entered for the runs to process, and EPA's PM guidance requires the analysis to use data consistent with that used in the regional emissions analysis for transportation conformity. CDOT has obtained these data from APCD; APCD only provided data for winter and summer seasons, so this analysis will use MOVES defaults for the spring season. Data for the fall season will not be needed, since the emission rates for the fall season will be mapped based on fuel composition captured by the other three seasons.

3.3.2 Vehicle Age Distribution

CDOT obtained these data from APCD. The vehicle age distribution input for the modeling is based on a composite of vehicle registration data for 2017 from seven Denver area counties (Adams, Arapaho, Boulder, Broomfield, Denver, Douglas, and Jefferson). These data will be used to represent the age distribution in 2050.

3.3.3 Fuel

Regional-specific parameters for fuel composition are not available. Therefore, the default parameters in MOVES3 will be used, consistent with APCD's standard practice and EPA guidance.

3.3.4 Inspection and Maintenance Parameters

Existing and anticipated future vehicle inspection and maintenance (I/M) program parameters for the Denver metropolitan area were obtained by CDOT from APCD. I/M inputs do not affect PM emissions rates in MOVES, but they are used in order to be consistent with the modeling conducted for other purposes in the project area.

3.3.5 Link Source Type

Link source type inputs are used to define the fraction of travel on each link by vehicle type. Two separate sets of MOVES runs will be conducted, for light-duty vehicles and for trucks, so two sets of link source type inputs will be needed, one with fractions for the four types of MOVES light-duty vehicles (MOVES sourcetypes 11, 21, 31, and 32), and one with fractions for the nine types of heavy vehicles, including buses (MOVES sourcetypes 41, 42, 43, 51, 52, 53, 54, 61, and 62).

Unlike the project's general-purpose lanes, the proposed express lanes will only permit usage by light-duty vehicles and buses. A third set of link source type fractions representing the express lane vehicle mix could be developed. However, including buses in the "truck" group, and not modeling emissions for any buses in the express lanes, is planned for three reasons. First, only one Regional Transportation District (RTD) bus route currently uses the corridor, so buses are a very small fraction of total travel.

Second, CDOT is planning to provide traffic volume estimates only for light-duty vehicles and trucks, and not separate estimates for bus volumes. Finally, including all bus emissions in the truck group and placing those emissions in the general purpose lanes in the dispersion modeling will have the effect of moving those emissions closer to near-road receptors, which is conservative relative to modeling some of these vehicles in the express lanes farther from receptors.

APCD provided CDOT Automated Traffic Recorder (ATR) data by Highway Performance Monitoring System (HPMS) class (if available) for representative freeway and arterial segments, and these data will be used, along with MOVES default estimates by vehicle miles traveled (VMT) by sourcetype, to develop link source type inputs for the two groups of vehicles.

3.3.6 Links

As noted above, a links input table will be created that represents all possible combinations of road type (urban restricted and unrestricted access), speed, and grade in order to generate a lookup table of emission factors applicable to any project link.

3.4 Road Dust Emission Factors

Re-entrained road dust must also be considered, following EPA's PM hot-spot guidance. The guidance discusses estimating paved road dust emissions using AP-42 or alternative local methods developed for local-specific conditions. Colorado APCD does not use the standard AP-42 emissions factors for road dust. The Denver region has typically employed factors that account for both ongoing re-entrained road dust and emissions due to road sanding (historically, now deicing) in the winter months. Additionally, CDOT and the local governments routinely make enforceable commitments for road dust emissions reductions as part of the regional transportation conformity process. Use of Denver-specific factors that were developed based on monitoring studies conducted in 1989 and 1990 has been approved by EPA, and they are applied in State Implementation Plan development and regional transportation conformity analyses. CDOT obtained the necessary re-entrained road dust emission factors developed by APCD accounting for applicable emissions reductions commitments for use in estimating total PM_{10} emissions for each project link and each season. Since deicing materials are only needed in the winter months, those factors will only be applied to links during those months; emissions factors for normal re-entrained dust will be applied for the entire year.

According to EPA's PM hot-spot guidance, modeling road dust for $PM_{2.5}$ is only required in $PM_{2.5}$ nonattainment and maintenance areas where road dust has been found to be a significant contributor to the $PM_{2.5}$ air quality problem. Since the project is not in such an area, $PM_{2.5}$ road dust will not be modeled.

3.5 Emission Rates for AERMOD Modeling

Link-level activity by time period (see **Table 3**) and road grade will be combined with the emission factor lookup tables developed using MOVES to calculate hourly link-level emission rates to be used in AERMOD. The hourly activity data includes speed and traffic volume for trucks and non-trucks. The time period, season, speed, and road grade will be used as keys to match the emission factor for each link and time period. The emission rate (g/second) for a link and each of four time periods accounted for in the traffic data will be calculated from the MOVES emission factor (g/mile) lookup tables. Emission rates will account for vehicle activity (number of vehicles), fleet mix, and other link parameters from the MOVES emissions tables, such as vehicle speed.

Table 3. Traffic time periods

Time Period	Hours
AM Peak	6 AM – 9 AM
Midday	9 AM – 3 PM
PM Peak	3 PM – 7 PM
Evening	7 PM – 6 AM

4.0 AERMOD Modeling for Particulate Matter Concentrations

Air quality $PM_{2.5}$ and PM_{10} dispersion modeling will be performed using AERMOD (version 21112), as described in EPA's PM hot-spot guidance. Modeling will be completed for the Proposed Action scenario for the year 2050 and two project areas identified by CDOT (see **Figures 2 and 3**): (1) from west of the Interstate 76 (I-76) interchange to east of the York Street interchange (the west project area) and (2) between the west project area and west of the Quebec Street interchange, including the Vasquez Boulevard interchange and east along East 56th Avenue (east project area). The modeling project area encompasses a 500-m buffer zone from the highways. Environmental justice communities, schools, and trailheads along the project corridor are located in these areas. For each scenario, the team will model 24-hour average PM_{10}, 24-hour average $PM_{2.5}$, and annual average $PM_{2.5}$ concentrations. Design concentrations will be calculated using the model output and appropriate background data for comparison of the Proposed Action scenarios with the NAAQS, following EPA's PM hot-spot guidance. Comparisons between the No Action and Proposed Action scenarios will also be made, as needed.

Figure 2. West project area from west of the Interstate 76 (I-76) interchange to east of the York Street interchange selected for modeling.

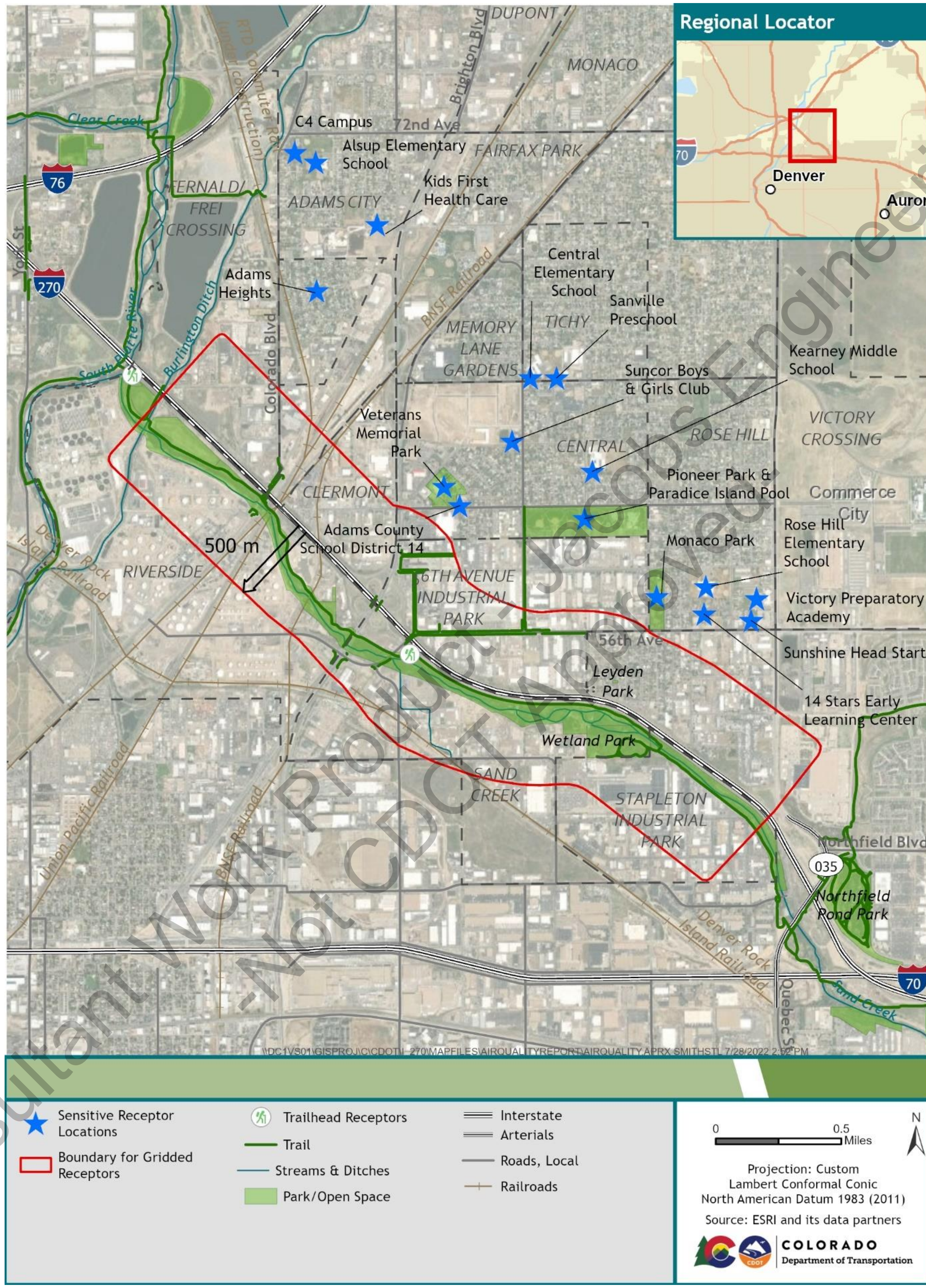

Figure 3. East project area between the west project area and west of the Quebec Street interchange, including the Vasquez Boulevard interchange and east along East 56th Avenue.

4.1 Emission Source Layouts and Input Parameters

The link-level traffic activity data and roadway geometry provided by CDOT will be reviewed to develop the emission source layouts and source parameters for the AERMOD dispersion model. Emissions inputs will be from the MOVES3 modeling described in Section 3. The complexity and level of refinement of the AERMOD source layouts will be determined from the travel activity data and roadway geometry files. The layouts will include lane-level representation of the links where necessary (e.g., to avoid placement of receptors within the exclusion zone of volume sources). No nearby sources outside the project area will be included as they are appropriately reflected in the representative background concentration.

EPA's PM hot-spot guidance provides flexibility on how roadway emission sources can be modeled in AERMOD, including the use of area or volume sources. Adjacent volume sources will be used in AERMOD to characterize vehicle emissions and the initial dispersion conditions for each link or lane. Appropriate volume source parameters, as defined in EPA's PM hot-spot guidance, will be calculated based on link geometry and the mix of trucks and non-trucks (fleet mix) in each traffic link for each time period (see **Table 4**).

Table 4. Summary of link/lane source input parameters for AERMOD

Input Parameter	Value
Lane width, *w*	12 feet (3.66 meters)[a]
Initial lateral dimension, σ_{yo}	$w \div 2.15$
Initial vertical dimension (height, H)	1.7 times the weighted average vehicle height for each lane or link[b]
Initial vertical dispersion coefficient, σ_{zo}	H ÷ 2.15
Release height, *Relhgt*	0.5 × H

[a] All lanes except single-lane ramps (*w* = 15 feet) and some multi-lane intersections (*w* = 11 feet).

[b] The weighting is based on the traffic volume of trucks and non-trucks, where the average vehicle height is taken as 4.0 meters for trucks and 1.53 meters for non-trucks.

For the Proposed Action scenario, links for new and modified roadway geometry, such as the new tolled express lanes and auxiliary lanes, arterials, and ramps, will be developed. Because setting up the roadway source layout in AERMOD is time-intensive, this will be done after the final roadway geometry (e.g., lane locations, number of lanes, roadway widths) is received from CDOT. Once the AERMOD source setup is complete, it will be reviewed by CDOT and FHWA before setting up the receptor network, which will depend on the placement of the roadway sources (e.g., to locate receptors as close as five meters from the edge of roadways).

4.2 Receptor Layouts and Input Parameters

The AERMOD receptor grid will be developed through consultation with CDOT and FHWA to ensure adequate and appropriate coverage of areas where the public gathers (i.e., where the public lives, works, and plays). Development of the receptor network will be informed by the EPA PM hot-spot guidance with an emphasis on such gathering areas, including discrete locations with sensitive populations such as schools, environmental justice communities, and trailheads. A quality assurance (QA)/quality control (QC) process will ensure that no receptors fall within a volume source exclusion zone. In some situations, as mentioned above, the roadway must be characterized at the lane level to avoid exclusion zone issues, even if single lanes are within a single link and the traffic does not vary across those lanes.

A gridded network of receptors will be located from the right-of-way (ROW) line to 100 meters from the ROW line along the roadways in the Proposed Action (with receptors no closer than five meters from the edge of roadways), where receptors will be spaced approximately 25 meters apart in the vicinity of residential areas and approximately 50 meters apart in the vicinity of industrial areas. Between 100 meters from the ROW line and 500 meters from the ROW line, the gridded receptors will be spaced approximately 50-100 meters apart, with spacing increasing with distance from the roadways. The 500-meter extents for the modeling areas are depicted in Figures 2 and 3. Application tools in the commercially-available AERMOD View software, such as the Cartesian Plant Boundary and Fenceline Grid tools, will be used to generate and modify the gridded network of receptors. Receptors will not be placed in locations where the general public is restricted from access (e.g., along the railroad tracks adjacent to Brighton Boulevard). The resulting gridded network of receptors will provide a level of resolution sufficient to capture maximum concentrations and concentration gradients. Additional receptors will be included at selected discrete sensitive locations outside of the 500-meter buffer zone (labeled in Figures 2 and 3) to capture locations identified by the public during a public comment period for the Proposed Action. The height of receptors will be specified as 1.8 meters above ground level. Once the receptor network setup is complete, it will be reviewed by CDOT and FHWA.

Use of the flat terrain model option is planned for this analysis. This option reflects that, for practical purposes, the base elevations of receptors and sources in the project area are the same. This is consistent with EPA's PM Hot-Spot Guidance that the project area should be modeled as having flat terrain in most situations. Modeling with flat terrain can be considered a conservative approach, in contrast with modeling with elevated terrain. Where appropriate, elevated roadways will be modeled by adding the roadway elevation above ground level to the release height input for the volume sources.

Urban dispersion in AERMOD will be applied using a population of 3.2 million, which is the approximate population of the metropolitan area of Denver in 2022 (Metro Denver Economic Development Corporation 2022). Plume depletion and particle deposition will not be modeled.

4.3 Meteorology Inputs

Five years of AERMOD-ready meteorological data will be used in the dispersion modeling, per EPA conformity guidance for off-site data. The Colorado APCD, which makes recommendations on data to be used for regulatory modeling throughout the state, provided the meteorological data that will be used in the dispersion modeling. Those data were produced by AERMET (version 19191) with the ADJ_U* option enabled[1] for two different surface meteorology stations: one at the Denver Stapleton International Airport[2] and one at the Asarco Globe Plant. APCD determined that the Stapleton site can be considered representative of the Quebec Street interchange and the Asarco site can be considered representative of the York Street interchange. However, neither site is considered as adequately representative of the Vasquez interchange. Based on guidance from APCD, the Asarco site meteorological data will be used to model the west project area (I-76 interchange) and data from both sites will be used to model the east project area (Vasquez interchange). **Figure 4** shows the location (in blue) of the two meteorology stations and **Figure 5** shows the wind roses for the two sites.

[1] The ADJ_U* option adjusts the surface friction velocity to improve AERMOD predictions under low wind speed and stable atmospheric conditions and is recommended in EPA's Guideline on Air Quality Models (Appendix W to 40 CFR Part 51; EPA 2017) when measurements do not include turbulence parameters, as is the case for the data used here.

[2] Denver Stapleton International Airport refers to the previous site of Denver's main airport that was located near the I-270/I-70 interchange.

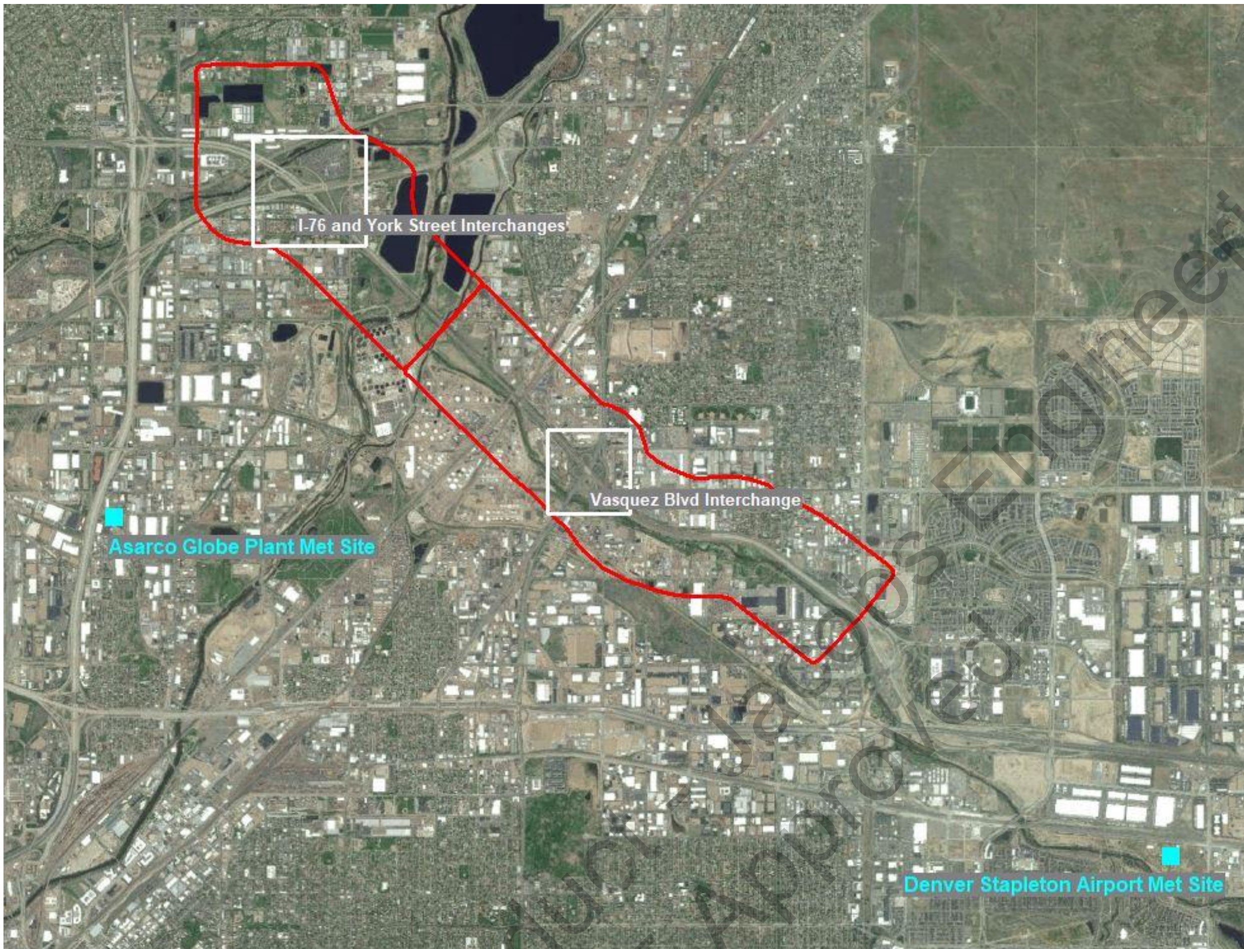

Figure 4. Location of the two meteorology stations (Asarco Globe Plant and Denver Stapleton International Airport) shown by blue markers. The extent of I-270 in the project area is indicated by the red boundary lines. The interchanges within the two areas to be modeled are indicated by white boxes.

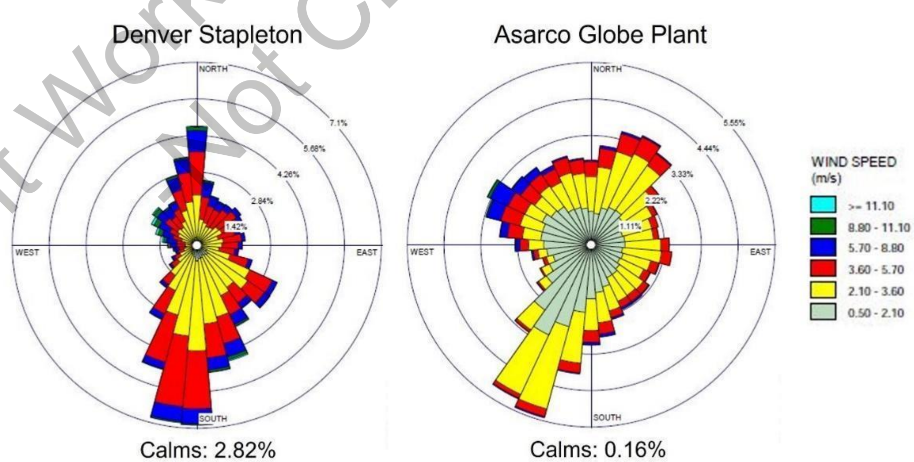

Figure 5. Wind roses for the Denver Stapleton International Airport (Denver Stapleton) and Asarco Globe Plant meteorology data provided by APCD. Data for Denver Stapleton are for the years 1990-1994; data for Asarco Globe Plant are for the years 1993, 1994, and 1998-2000. For the Asarco Globe Plant, wind speeds are below 0.5 m/s for 69 hours on 37 separate days.

5.0 Background Concentrations and Design Concentrations

Modeled concentrations from the AERMOD simulations will be combined with PM background concentration data (2017-2019) provided by APCD to calculate design concentrations following EPA's PM hot-spot guidance. For 24-hour average $PM_{2.5}$, design concentrations will initially be calculated using the Tier 1 approach.

5.1 Background Concentrations

Representative background concentrations for PM_{10} and $PM_{2.5}$ were calculated by the APCD using data from the EPA Air Quality System (AQS). The monitoring data are from 2017 to 2019 at the Commerce City monitoring site (AQS site ID 08-001-0008). $PM_{2.5}$ measured concentrations for 2017 and 2018 were adjusted in APCD's analysis by removing data on dates when the particulate samplers are believed to have been affected by wildfire smoke. PM_{10} measured concentrations were not adjusted because days with the highest concentrations of PM_{10} did not coincide with days determined to be impacted by wildfire smoke or blowing dust. APCD followed guidance in the EPA memorandum *Additional Methods, Determinations, and Analyses to Modify Air Quality Data Beyond Exceptional Events* (EPA 2019) for excluding those data. EPA Region 8 concurred with the approach used by the APCD to calculate the background concentrations to be used in calculating design concentrations for the air quality particulate analysis.[3] The background concentrations (2017-2019) calculated by the APCD that are appropriate for combining with modeled concentrations to calculate design concentrations for 24-hour average PM_{10} and $PM_{2.5}$ (Tier 1) and annual average $PM_{2.5}$ are

- PM_{10} (24-hour): 124 $\mu g/m^3$
- $PM_{2.5}$ (24-hour): 23 $\mu g/m^3$ (including the adjustment for wildfire days)
- $PM_{2.5}$ (Annual mean): 9.5 $\mu g/m^3$ (including the adjustment for wildfire days)

5.2 Design Concentrations

Design concentrations for annual average $PM_{2.5}$ and 24-hour average $PM_{2.5}$ and PM_{10} will be calculated according to methods in EPA's PM hot-spot guidance. For the east project area, for which both meteorological datasets will be used for the AERMOD modeling, the highest design concentrations for annual and 24-hour average $PM_{2.5}$ and 24-hour average PM_{10} across the two datasets will be determined.[4] For each pollutant and averaging period of concern, the design concentrations for the Proposed Action will be compared to the NAAQS. In the event that any design concentration for the Proposed Action exceeds the NAAQS, the design concentrations for the Proposed Action scenario will be compared to those for the No Action scenario. However, if an exceedance is found for 24-hour average $PM_{2.5}$, those design concentrations will be recalculated using the less conservative Tier 2 approach and compared to the NAAQS before comparison between the two scenarios.

6.0 Reporting

An Air Quality Particulate Matter Modeling Technical Report that documents all aspects of the modeling analysis, including the emissions and dispersion modeling approaches, input data, key assumptions, analysis methods, and the modeling results will be prepared using this work plan the starting point for the initial draft. The CDOT AQ-PLAG will be followed to ensure the report is sufficient for inclusion in the

[3] Concurrence is noted in an email from Gregory Lohrke, U.S. EPA Region 8, Air and Radiation Division, sent to Curt Frischkorn at Colorado Department of Transportation on July 8, 2021.

[4] This approach follows guidance from APCD for cases when available meteorological data is deemed not adequately representative of dispersion conditions at the source site, as described in an undated document titled *Meteorological Determinations and Application of Dispersion Models* guidance received via email on April 27, 2021.

I-270 NEPA EA documentation. The initial draft of the technical report will be delivered to CDOT for review. Following review by CDOT, revisions will be made as necessary and two more drafts will be prepared before the final version: the second draft will be reviewed by CDOT and FHWA, and the third draft will be reviewed by CDOT, FHWA, EPA, and the APCD. Each draft will include revisions to address comments from the reviewers.

The modeling results will be presented as isopleth contour plots of modeled concentrations as well as in tables of modeled concentrations for each pollutant, averaging period, scenario, and comparison of the No Action and Proposed Action scenarios, as needed. The tabular results will be presented for the highest design concentrations across all receptors and for all sensitive receptors in specific selected locations (e.g., at schools, trailheads, and the maximum design concentration in environmental justice communities).

7.0 Delivery of Electronic Files

All relevant electronic files will be delivered to CDOT upon conclusion of the PM modeling analysis and reporting to accompany the overall air quality report for the project EA. The electronic files will include modeling input and output files, spreadsheets with model inputs, input data, and post-processing files. Based on instruction from CDOT on the preferred method of delivery, the files will be delivered, for example, on an external hard disk or upload through an online platform, or both.

8.0 References

Colorado Department of Transportation (CDOT). 2019. *Air Quality Project-Level Analysis Guidance*. February. https://www.codot.gov/programs/environmental/air-quality/assets/cdot-aq-plag.

Metro Denver Economic Development Corporation (MetroDenverEDC). Accessed February 8, 2022. https://www.metrodenver.org/regional-data/demographics/population.

U.S. Environmental Protection Agency (EPA). 2017. *Revisions to the Guideline on Air Quality Models: Enhancements to the AERMOD Dispersion Modeling System and Incorporation of Approaches To Address Ozone and Fine Particulate Matter.* https://www.epa.gov/sites/default/files/2020-09/documents/appw_17.pdf.

U.S. Environmental Protection Agency (EPA). 2019. *Additional Methods, Determinations, and Analyses to Modify Air Quality Data Beyond Exceptional Events*. https://www.epa.gov/sites/default/files/2019-04/documents/clarification_memo_on_data_modification_methods.pdf.

U.S. Environmental Protection Agency (EPA). 2021a. *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in* $PM_{2.5}$ *and* PM_{10} *Nonattainment and Maintenance Areas*.

U.S. Environmental Protection Agency (EPA). 2021b. "Official Release of the MOVES3 Motor Vehicle Emissions Model for SIPs and Transportation Conformity." *Federal Register*. Vol. 86, No. 4, January 7.

Appendix H is being finalized and will be provided separately.

Appendix H
Air Quality Particulate Matter Modeling

Contents

Figures

Tables

Acronyms and Abbreviations

Acronym	Definition
μg/m³	microgram(s) per cubic meter
g/sec	grams per second
g/veh/mi	grams per vehicle per mile
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
APCD	Air Pollution Control Division
AQ-PLAG	*Air Quality Project-Level Analysis Guidance*
AQS	EPA Air Quality System
CDOT	Colorado Department of Transportation
CRS	Colorado Revised Statutes
EA	Environmental Assessment
EB	eastbound
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
GUI	graphical user interface
I/M	Inspection and maintenance program
I-270	Interstate 270
I-70	Interstate 70
I-76	Interstate 76
m	meter(s)
MOVES	Motor Vehicle Emissions Simulator
NA	not applicable
NAAQS	National Ambient Air Quality Standards
NB	northbound
NEPA	National Environmental Policy Act
PM	particulate matter
PM_{10}	particulate matter less than 10 microns in aerodynamic diameter
$PM_{2.5}$	particulate matter less than 2.5 microns in aerodynamic diameter
POAQC	project of air quality concern
ROW	right-of-way
RunSpec	run specification for MOVES
SB	southbound
U.S.	United States
WB	westbound

1.0 Introduction

This report presents results of the air quality particulate matter (PM) modeling analysis for the Interstate 270 (I-270) Corridor Improvements project proposed by the Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA), in conjunction with Adams County and Commerce City, Colorado. The project is described in Sections 1 and 2 of the Environmental Assessment (EA) and EA Appendix B. The PM modeling analysis includes modeling PM with diameter equal to or less than 2.5 micrometers ($PM_{2.5}$) and PM with diameter equal to or less than 10 micrometers (PM_{10}). Based on the results of this PM modeling analysis, the Proposed Action for the I-270 Corridor Improvements project will not cause or contribute to new violations of the PM National Ambient Air Quality Standards (NAAQS), as shown in Section 6 of this report.

2.0 Methodology for the Air Quality Particulate Modeling Analysis

The $PM_{2.5}$ and PM_{10} air quality modeling analysis was completed based on the requirements of (1) the National Environmental Policy Act (NEPA), (2) United States (U.S.) Environmental Protection Agency (EPA) guidance for these types of analyses, (3) Colorado Revised Statutes (CRS) Section 43-1-128, and (4) the CDOT Air Quality Project-Level Analysis Guidance (AQ-PLAG), Version 1 (CDOT 2019), as described in the Air Quality Particulate Matter Modeling Work Plan (the Work Plan; in Appendix G). Although it was determined that the I-270 Corridor Improvements project is not a project of air quality concern (POAQC) and a hot-spot analysis for transportation conformity purposes is not required, the PM modeling analysis was informed by EPA's *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas* (EPA 2021). The modeling approach also went beyond the EPA hot-spot guidance to include modeling PM concentrations at sensitive locations that are farther than 500 meters from the project, to address comments from the public, as well as on public trails within the CDOT right-of-way (ROW).

Section 3 of this report summarizes the emissions modeling that was performed for the analysis using the Motor Vehicle Emissions Simulator (MOVES) model (MOVES3 version 3.0.3); Section 4 summarizes the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) (version 21112) dispersion modeling that was performed; Section 5 describes the calculation of the design concentrations; and Section 6 presents the analysis results.

3.0 MOVES Modeling for Particulate Matter Emission Factors and Emission Rates

MOVES3 runs were performed to estimate PM emission factors for a lookup table used to develop link-specific emission rates for AERMOD. Due to the large size of the lookup table of emission factors, it is not included within this report, but it is available electronically. In order to calculate the hourly link-level emission rates to use in AERMOD, link-level traffic activity and road grade were combined with (1) link lengths based on the detailed roadway sources layout in AERMOD, and (2) emission factors from the lookup table. The methodology and input data for running MOVES are summarized below and described in more detail in the Work Plan.

3.1 MOVES Runs – Overview of Approach

MOVES was run at the Project Scale to model running exhaust, crankcase running exhaust, brake wear, and tire wear $PM_{2.5}$ and PM_{10} emission factors for on-road urban restricted and unrestricted links (no "off-network" links were modeled) for calendar year 2050. MOVES runs were completed for each of three seasons, with appropriate inputs for the combination of fuels used in each season. Over the course of a year, there are only three possible combinations of gasoline and diesel fuel sold in the Denver metro area, so only three "fuel seasons" needed to be modeled to capture the range of fuels.

Emission factors were developed for both light-duty and heavy-duty (truck and bus) vehicle categories, with appropriate mapping of MOVES source types to truck and non-truck categories. This resulted in a total of six MOVES runs to develop a complete set of emission factors for all seasons and vehicle types.

The MOVES modeling approach used in this analysis was designed to generate a project-scale lookup table of emission factors that were applied to link-level traffic data outside of MOVES in order to calculate emission rates for each link modeled in AERMOD. This approach results in the same emission rates as the approach that is outlined in EPA's PM hot-spot guidance and was selected for the flexibility it offers. If traffic data change, or if new links are added to the analysis (which occurred for this project, in response to public input), updated link-level emissions could be calculated without the need to revise MOVES inputs and re-run the MOVES model. The approach described in EPA's PM hot-spot guidance is designed to minimize the number of necessary MOVES runs, and assumes that modelers will use project-specific traffic data as part of the MOVES inputs. For this analysis, where MOVES is used to generate a project-scale lookup table, there is no need to model multiple time periods during the day in MOVES to capture changes in traffic volumes, speeds, or car/truck mix. Instead, these factors are incorporated when the MOVES lookup table of emission factors are applied to link-level traffic data outside of MOVES. The project traffic data are available for four time periods during the day, and the modeled MOVES emission factors (by vehicle type, speed, and grade) were applied to the four sets of traffic data to calculate emission rates for each link by time period.

3.2 Run Specification Inputs

The MOVES run specification (RunSpec) inputs that were used to define the parameters of the MOVES model for this analysis are summarized in **Table 1**.

Table 1. MOVES RunSpec options.

Navigation Panel	Model Selection
Scale	Project Scale; inventory calculation type
Time Spans	Hour; weekdays; January/April/July (representing the three fuel seasons); calendar year 2050
Geographic Bounds	Adams County
Vehicles	All MOVES3 vehicle and fuel type combinations
Road Types	Urban restricted access, urban unrestricted access
Pollutants and Processes	$PM_{2.5}$ and PM_{10}; running exhaust and crankcase running exhaust, brake wear, tire wear
General Output	Units of grams and miles
Output Emissions Detail	Road type

3.3 Project Data Manager

Table 2 summarizes the MOVES Project Data Manager inputs.

Table 2. MOVES Project Data Manager inputs.

Project Data Manager Tab	Data Source
Meteorology Data	• APCD[a] (Winter and Summer) • MOVES defaults (Spring)
Age Distribution	APCD
Fuel	MOVES default
Retrofit	No inputs (N/A)

Project Data Manager Tab	Data Source
Inspection & Maintenance (I/M) Program	APCD
Link Source Type	APCD
Links	Generated using data provided by APCD

[a] APCD is the Colorado Air Pollution Control Division

3.4 Road Dust Emission Factors

Re-entrained PM_{10} road dust was also considered, following EPA's PM hot-spot guidance. **Table 3** lists the road dust emission factors developed by APCD and included in the lookup table of MOVES emission factors. To estimate road dust and sanding emissions for this analysis, APCD used controlled sanding and road dust emissions estimates from the most recent PM_{10} maintenance conformity modeling, which was based on Section 3.4 of the Colorado State Implementation Plan for PM_{10} Revised Technical Support Document (Colorado Department of Public Health and Environment 2005). It should be noted that the approach of using a road dust emission rate assumes an infinite reservoir of dust and sand on the highway surface that is re-suspended into the air in direct proportion to vehicle miles traveled. This is a conservative approach to estimating airborne dust since, in reality, the dust and sand would be gradually depleted from the road surface as it is re-suspended and settled out away from the highway.

Table 3. PM_{10} road dust emission factors.

	Urban restricted access road			Urban unrestricted access road		
PM_{10} Road Dust Emission Factor (g/veh/mi)	Baseline	Sanding	Total	Baseline	Sanding	Total
Winter months	0.167892407	0.051308817	0.219201224	0.354265543	0.054924713	0.409190256
All other months	0.167892407	NA	0.167892407	0.354265543	NA	0.354265543

Note: The "baseline" road dust emission factor corresponds to any time of year, while the "sanding" emission factor corresponds to excess road dust emissions from deicer/antiskid material used during winter months (November through March). The "sanding" emission factor is added to the "baseline" emission factor during the winter months. NA indicates that the sanding emission factor is not applicable.

According to EPA's PM hot-spot guidance, modeling road dust for $PM_{2.5}$ concentrations is only required in $PM_{2.5}$ nonattainment and maintenance areas where road dust has been found to be a significant contributor to the $PM_{2.5}$ air quality problem. Since the I-270 Corridor Improvements project is not in such an area, $PM_{2.5}$ road dust was not modeled for this analysis. More information on the application of road dust emission factors in this analysis is available in the Work Plan.

3.5 Emission Rates for AERMOD Modeling

Link-level emission rates for the AERMOD modeling were calculated for each hour of the day using: project traffic activity data (average speed, average truck and non-truck traffic volumes, the average delay for vehicles stopped at intersections, and one-half the average speed for vehicles accelerating away from intersections) by traffic time period (see **Table 4**); road grade; link length as defined by the source representation of links in AERMOD; and the MOVES emission factor lookup table. Emission rates (in units of g/sec) were developed for each of the four seasons modeled in AERMOD based on a mapping of the "fuel seasons" in MOVES to the seasons defined in AERMOD. Note that because there are only three different fuel combinations used throughout the entire year, three "fuel seasons" represented in the MOVES modeling are mapped appropriately by month to four meteorological seasons modeled in AERMOD.

Table 4. Traffic time periods.

Time Period	Hours of the Day
AM Peak	6 AM – 9 AM
Midday	9 AM – 3 PM
PM Peak	3 PM – 7 PM
Evening	7 PM – 6 AM

4.0 AERMOD Modeling for Particulate Matter Concentrations

$PM_{2.5}$ and PM_{10} dispersion modeling with AERMOD was completed for only the Proposed Action scenario (for the year 2050) in the two project areas identified by CDOT and illustrated in the Work Plan. Modeling for the No Action scenario was not necessary because the design concentrations (calculated using the appropriate modeled and background concentrations) for the Proposed Action scenario did not exceed the NAAQS (see Section 6).

The AERMOD View commercial software from Lakes Environmental was used in combination with project design and ROW data (as base map layers) to define the source and receptor locations for AERMOD. All input parameters and model options were entered through the AERMOD View graphical user interface (GUI), and the parallelized version of AERMOD within AERMOD View was used to execute the model simulations. Note that Lakes Environmental validates and documents that their parallelized version of AERMOD produces identical results to the AERMOD executable available directly from EPA; they validate this using an extensive database of test cases, including those used by EPA to evaluate AERMOD.

The following subsections illustrate how the traffic link emission sources were characterized and receptor networks were developed for the AERMOD modeling. More details on the methodology, input parameters, and model options for the AERMOD modeling are available in the Work Plan.

4.1 Characterizing Emission Sources

EPA's PM hot-spot guidance provides flexibility on how roadway emission sources can be modeled in AERMOD, including the use of area or volume sources. For this analysis, adjacent volume sources were used in AERMOD to characterize vehicle emissions and the initial dispersion conditions for each link (or lane) provided from the traffic modeling and analysis. Volume source parameters, as defined in EPA's PM hot-spot guidance, were calculated based on the geometry and daily average percentage of trucks and non-trucks (fleet mix) for each traffic link. Emission rates (see Section 3.5) for each traffic link were provided for the AERMOD modeling as "by-season-by-hour" variable emission rates in the AERMOD View GUI, which triggers AERMOD's use of the EMISFACT keyword. No nearby sources outside the project area were modeled, as they are appropriately reflected in the representative background concentration.

Figure 1 shows a partial view of the AERMOD View GUI zoomed in on adjacent volume sources representing traffic links in one of the two modeled project areas. The links shown include eastbound (EB) and westbound (WB) lanes of I-270, as well as on- and off-ramps connecting I-270 and southbound (SB) and northbound (NB) lanes of I-76 in the west project area. Each individual volume source is displayed in AERMOD View as a square with length of sides equal to the width of the volume source. It also displays, with a dashed line, the so-called "receptor exclusion zone" of each volume source as a circle encompassing the square. The adjacent volume sources were drawn using the Line Volume Source application tool in the AERMOD View GUI such that the centerline connecting individual adjacent sources was aligned with the centerline of the corresponding traffic link (or lane), guided by the roadway striping linework of the project design data. Volume source widths were based on lane widths in the project design data layer. The width of traffic lanes is 12 feet for all links except (1) single-lane ramps, which have a lane width of 15 feet, and (2) some multi-lane intersections, which have lanes that are 11 feet wide.

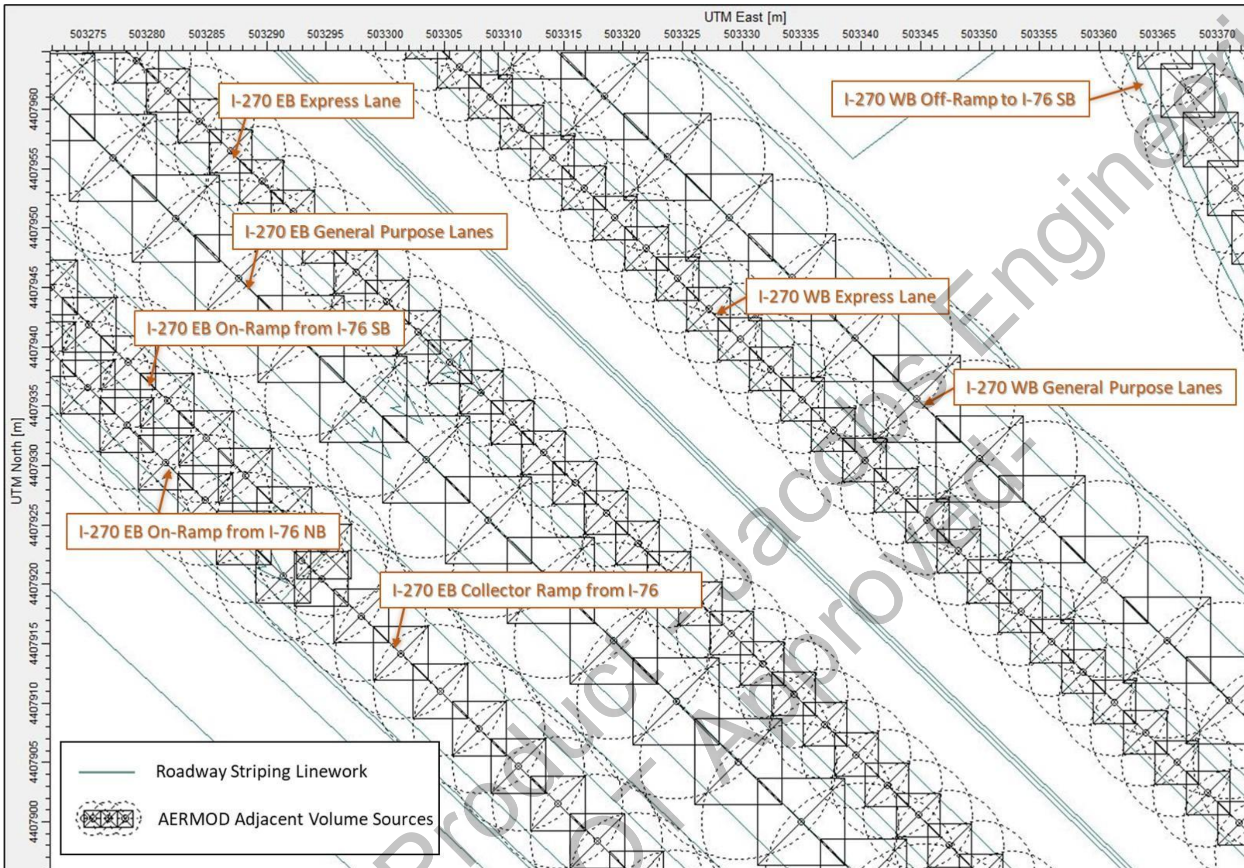

Figure 1. Adjacent volume sources representing vehicle emissions from traffic links in the I-270 Corridor Improvements project (west project area) as displayed in the AERMOD View GUI.

4.2 Receptor Placement

The AERMOD receptor network was developed to ensure adequate and appropriate coverage of areas where the public lives and gathers (e.g., residential areas, trailheads, schools, and parks) and to provide a level of resolution sufficient to capture maximum PM concentrations and PM concentration gradients. Development of the receptor network was informed by EPA's PM hot-spot guidance with an emphasis on gathering areas, including discrete locations with sensitive populations such as schools, environmental justice communities, and trailheads. As described in the Work Plan, the receptor network included gridded receptors located at the ROW line; these receptors went out to a distance of 100 meters from the ROW line along the roadways in the Proposed Action. They were spaced approximately 25 meters apart in the vicinity of residential areas, and approximately 50 meters apart in the vicinity of industrial areas. From 100 meters to 500 meters from the ROW line, gridded receptors were spaced approximately 50-100 meters apart, with the spacing increasing with distance from the ROW. The gridded receptors were developed using the Cartesian Plant Boundary and Fenceline Grid application tools in AERMOD View. Receptors were not located closer than five meters from the edge of any modeled roadway and were removed from locations where the general public is restricted from access (e.g., along the railroad tracks adjacent to Brighton Boulevard). Additional discrete receptors were placed at (1) sensitive locations outside of the gridded receptors, beyond 500 meters from the ROW line, to capture locations identified by the public during a public comment period for the Proposed Action; and (2) within the ROW on the Clear Creek Trail, the Sand Creek Regional Greenway, and the Colorado Front Range Trail. The height of receptors was specified as 1.8 meters above ground level.

Figure 2 shows a partial view of the AERMOD View GUI zoomed in on sources and receptors near the I-270/I-76 interchange in the west project area. The figure shows receptors placed along the ROW line (blue line), gridded receptors with closer spacing near I-270, and additional receptors placed on the Clear Creek Trail within the ROW. **Figures 3 and 4** show the complete source and receptor layouts for the west and east project areas.

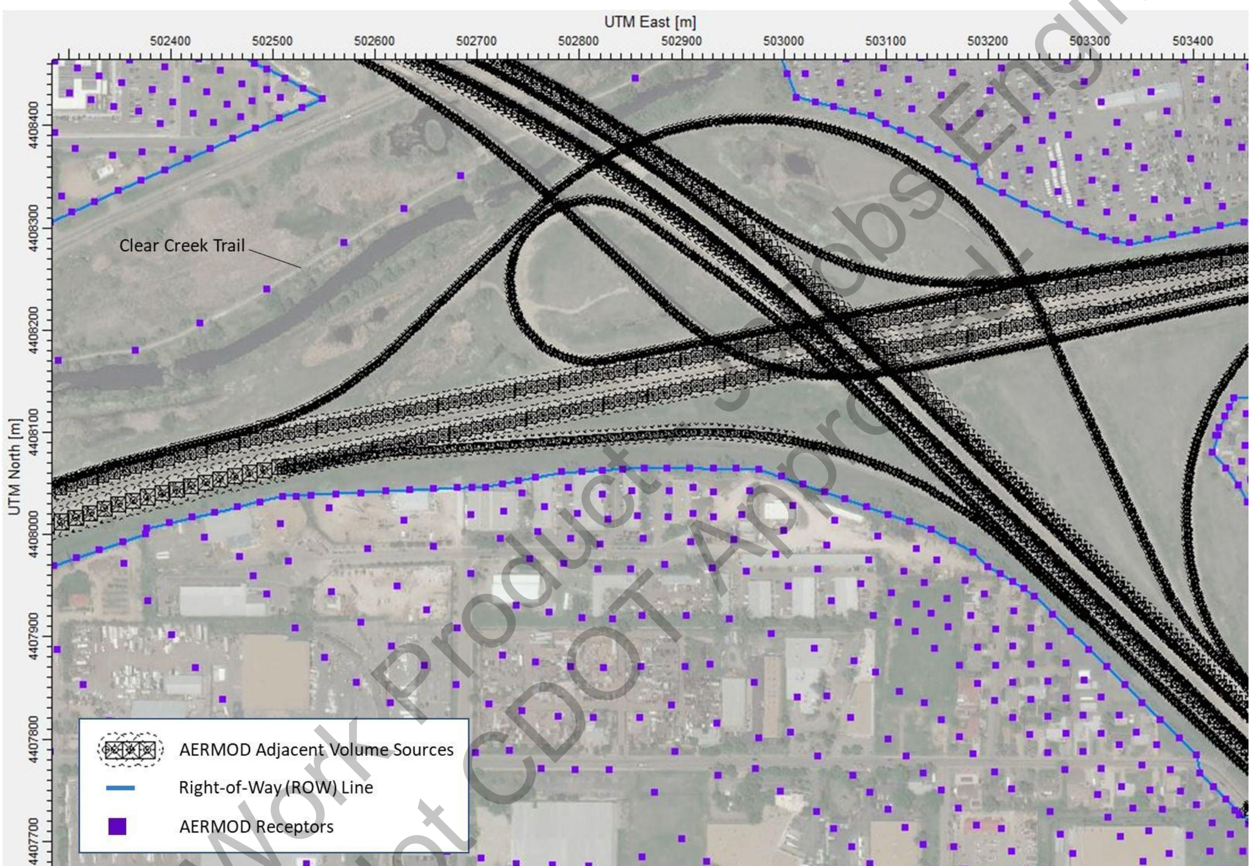

Figure 2. Illustration of receptor placement along the ROW line; gridded receptors are spaced more closely near I-270, and additional receptors are placed along Clear Creek Trail within the ROW.

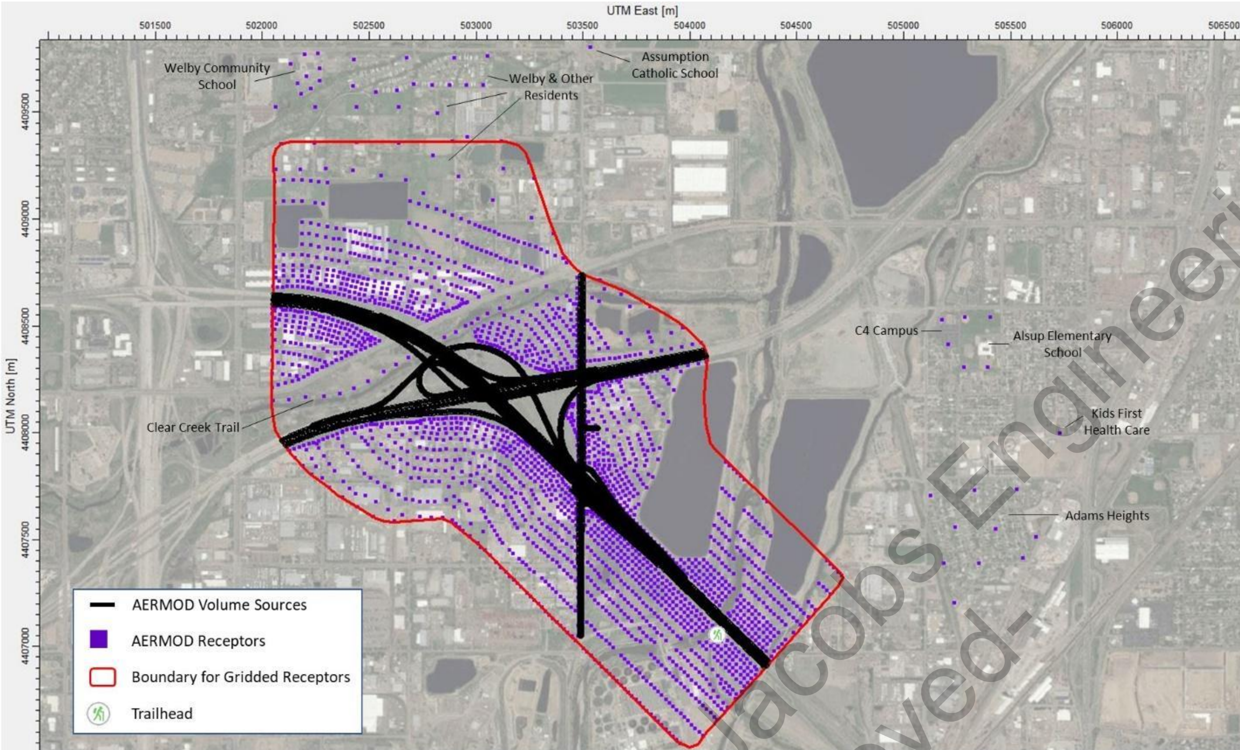

Figure 3. AERMOD sources and receptor network in the west project area. Sensitive locations where additional receptors were placed following the public comment period are labeled in the figure.

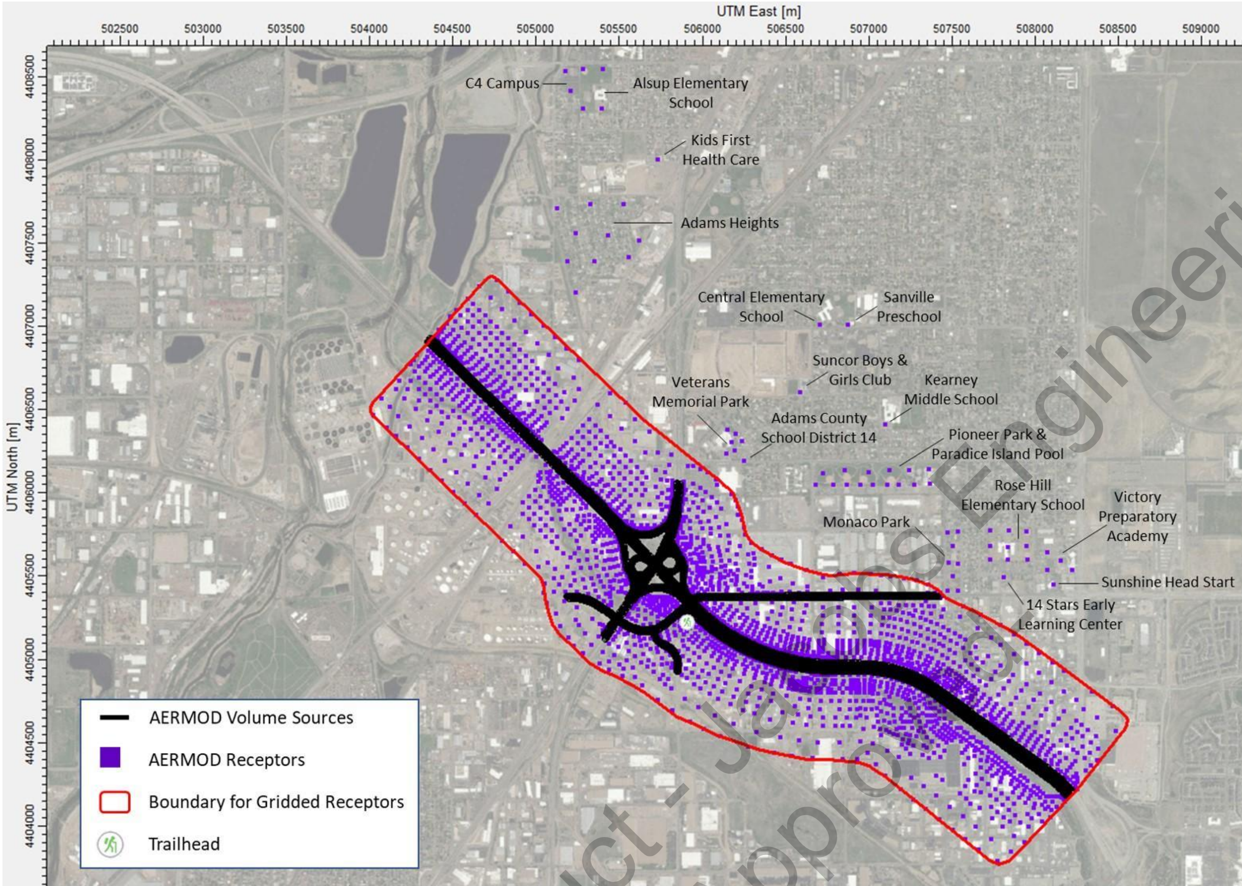

Figure 4. AERMOD sources and receptor network in the east project area. Sensitive locations where additional receptors were placed following the public comment period are labeled in the figure.

4.3 Meteorology Data and Other AERMOD Inputs

The most representative five years of AERMOD-ready meteorological data used for the dispersion modeling was provided by the APCD. The APCD determined that one set of meteorological data from the Asarco Globe Plant station was representative of the I-270/York Street interchange, and that dataset was used in modeling the west project area. The APCD also determined that available meteorological data did not adequately represent the Vasquez interchange, and therefore provided the two most representative datasets (the one from the Asarco Globe Plant station and one from the old Denver Stapleton International Airport station that was located near the I-270/I-70 interchange). Per guidance from the APCD, each of the datasets was used separately in modeling the east project area and the one that resulted in the highest modeled PM concentrations was selected. The locations of the Asarco and old Denver Stapleton meteorological stations, as well as the wind roses of the five-year datasets, are provided in the Work Plan. Other AERMOD modeling options and inputs (e.g., the population for urban dispersion) are also provided in the Work Plan.

5.0 Calculating Design Concentrations

Modeled PM concentrations from the AERMOD simulations were combined with representative background concentration data provided by the Colorado APCD to calculate design concentrations following EPA's PM hot-spot guidance.

Representative background concentrations for PM_{10} and $PM_{2.5}$ were calculated by the APCD using data from the EPA Air Quality System (AQS). The monitoring data are from 2017 to 2019 at the Commerce

City monitoring site (AQS site ID 08-001-0008). The background concentrations (2017-2019) calculated by the APCD that are appropriate for calculating design concentrations for 24-hour average PM_{10} and $PM_{2.5}$ (Tier 1) and annual average $PM_{2.5}$ are

- PM_{10} (24-hour): 124 µg/m^3
- $PM_{2.5}$ (24-hour): 23 µg/m^3
- $PM_{2.5}$ (Annual): 9.5 µg/m^3

More information on the background concentration data analysis is provided in the Work Plan.

Design concentrations for 24-hour average PM_{10} and $PM_{2.5}$ and annual average $PM_{2.5}$ were calculated according to methods in EPA's PM hot-spot guidance, where the background concentration was added to the appropriate modeled concentration at each receptor and the sum was rounded. Details on these calculations are below:

- PM_{10} (24-hour): Sixth highest 24-hour average modeled concentration (across the five years of meteorological data) plus background concentration, rounded to the nearest 10 µg/m^3 (for example, 155.000 rounds to 160, and 154.999 rounds to 150)
- $PM_{2.5}$ (24-hour): Average of 98^{th} percentile (eighth highest) 24-hour average modeled concentration for the five years of meteorological data plus background concentration, rounded to the nearest 1 µg/m^3
- $PM_{2.5}$ (Annual): Annual average (across the five years of meteorological data) modeled concentration plus background concentration, rounded to the nearest 0.1 µg/m^3

The maximum design concentration for each of the pollutants and averaging periods was compared to the appropriate NAAQS (24-hr PM_{10}: 150 µg/m^3; 24-hr $PM_{2.5}$: 35 µg/m^3; Annual $PM_{2.5}$: 12.0 µg/m^3). Because the maximum design concentrations for the Proposed Action were less than or equal to the relevant NAAQS, dispersion modeling and the calculation of design concentrations were not performed for the No Action scenario.

6.0 Modeling Analysis Results

The maximum PM design concentrations resulting from the Proposed Action for the I-270 Corridor Improvements project are summarized in **Table 5**. The maximum modeled contributions listed in the table are the appropriate modeled concentrations as described in Section 5.0 (e.g., the maximum sixth highest 24-hour average PM_{10} concentration). The 24-hr PM_{10} design concentration at all receptors in both the west and east project areas is less than or equal to the relevant NAAQS, and the 24-hr and annual $PM_{2.5}$ design concentrations at all receptors in both the west and east project areas are below the relevant NAAQS. **Table 6** lists the maximum design concentrations at the sensitive locations outside of the gridded receptors and at trailheads.

Table 5. Maximum PM_{10} and $PM_{2.5}$ design concentrations for the I-270 Proposed Action modeling analysis.

Pollutant and Averaging Period	Project Area	Maximum Modeled Contribution (µg/m³)	Background Contribution (µg/m³)	Maximum Modeled + Background Contributions (µg/m³)	Maximum Design Concentration (µg/m³)
24-hr PM_{10}	West	30.670	124	154.670	150
24-hr PM_{10}	East	30.631	124	154.531	150
24-hr $PM_{2.5}$	West	0.277	23	23.277	23
24-hr $PM_{2.5}$	East	0.230	23	23.230	23
Annual $PM_{2.5}$	West	0.181	9.5	9.681	9.7
Annual $PM_{2.5}$	East	0.149	9.5	9.649	9.6

Note: The higher maximum modeled contributions to the design concentrations for the east project area resulted from modeling with the Asarco Globe Plant meteorological station dataset.

Table 6. Maximum PM_{10} and $PM_{2.5}$ design concentrations at sensitive locations outside of the gridded receptors and at trailheads.

Location	24-Hr Avg. PM_{10} (µg/m³)	24-Hr Avg. $PM_{2.5}$ (µg/m³)	Annual Avg. $PM_{2.5}$ (µg/m³)
Adams County School District 14	130	23	9.5
Adams Heights Neighborhood	130	23	9.5
Alsup Elementary School	120	23	9.5
Assumption Catholic School	120	23	9.5
C4 Campus	120	23	9.5
Central Elementary School	130	23	9.5
Kearney Middle School	130	23	9.5
Kids First Health Care	120	23	9.5
Monaco Park	130	23	9.5
Pioneer Park & Paradice Island Pool	130	23	9.5
Rose Hill Elementary School	130	23	9.5
Sanville Preschool	130	23	9.5
Suncor Boys & Girls Club	130	23	9.5
Sunshine Head Start	130	23	9.5
Trailhead (East Project Area)	150	23	9.6
Trailhead (West Project Area)	150	23	9.7
Veterans Memorial Park	130	23	9.5
Victory Preparatory Academy	130	23	9.5
Welby Community School	130	23	9.5
Welby Area Residents	130	23	9.5
14 Stars Early Learning Center	130	23	9.5

Figures 5 through 8 show the locations of the maximum PM design concentrations in the west and east project areas. The maximum design concentrations occur closest to roadways, at receptors placed on the ROW line, five meters from the edge of a roadway, or on a trail within the ROW. **Figures 9 through 11** show examples of the rapid drop-off in design concentrations (before rounding) with distance from roadways in the Proposed Action. This is consistent with analyses that have shown near-road pollutant concentrations decrease rapidly to background concentration levels within about 500-600 feet from roadways (e.g., Liu et al. 2019; EPA 2014). The modeled concentrations from the Proposed Action decline by roughly half at 100 meters from the modeled roadway sources. The figures also show that the design concentrations are dominated by the background concentration contributions and are at near-background levels at sensitive receptors (e.g., schools, parks, and residential neighborhoods) beyond 500 meters from the roadway sources. **Figures 12 through 17** show the design concentrations (before rounding) at each receptor in the west and east project areas.

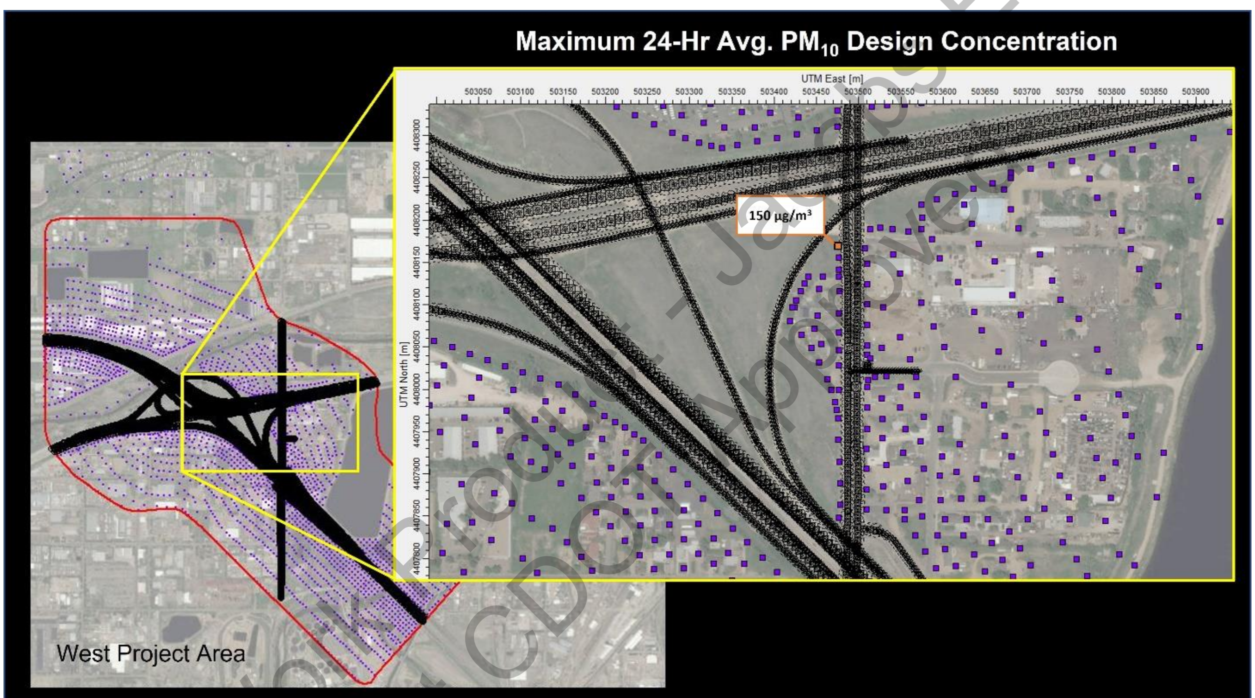

Figure 5. Location of receptor with the maximum 24-hr average PM_{10} design concentration in the west project area. The receptor (orange square) is located five meters from the edge of southbound York Street near East 70th Avenue, north of the I-270/York Street interchange and south of I-76.

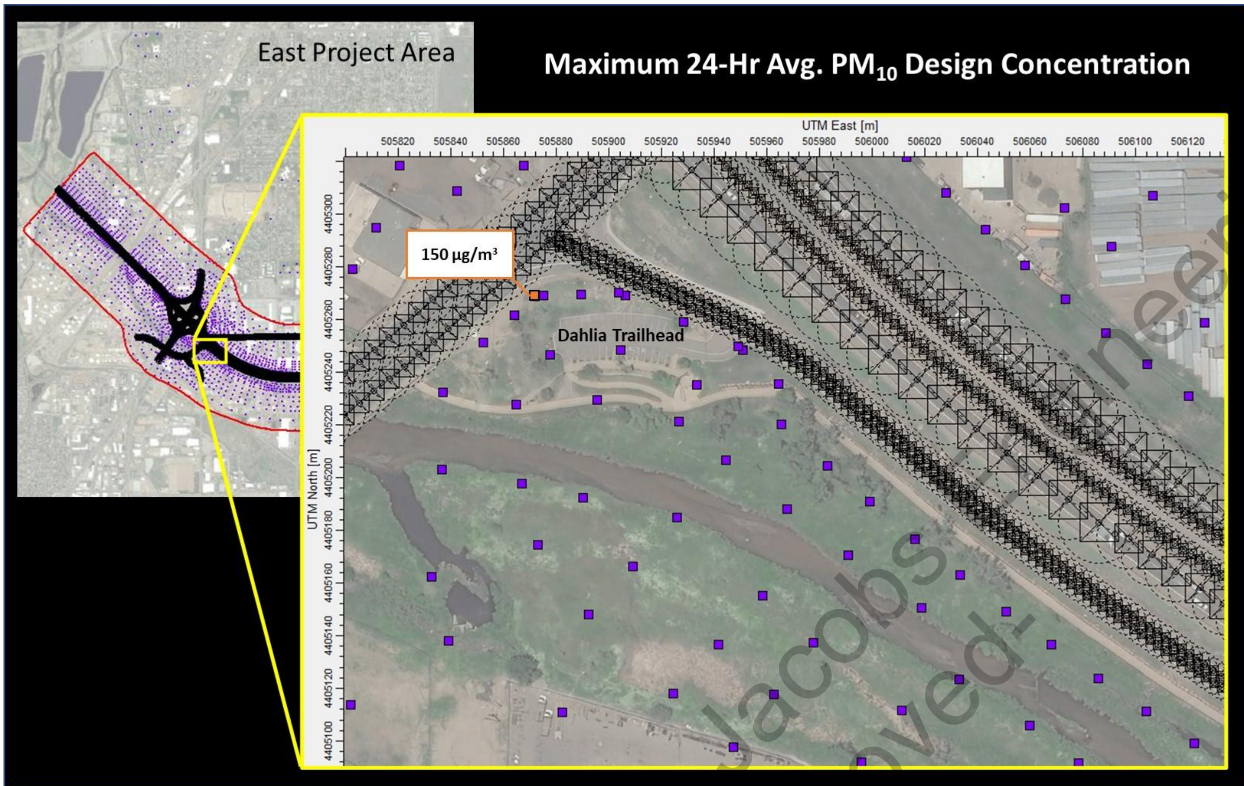

Figure 6. Location of receptor with the maximum 24-hr average PM_{10} design concentration in the east project area. The receptor (orange square) is located near the parking lot for the Dahlia Trailhead and the intersection of 56th Avenue and Sandcreek Drive.

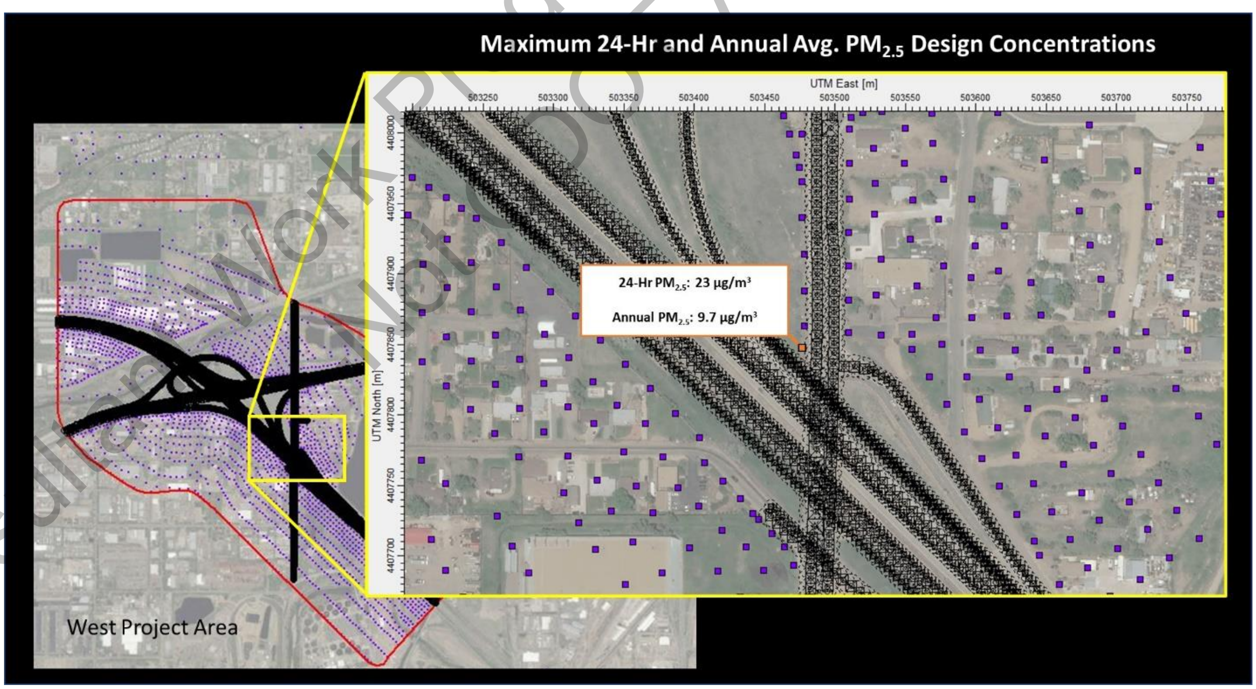

Figure 7. Location of receptor with the maximum 24-hr and annual average $PM_{2.5}$ design concentrations in the west project area. The receptor (orange square) is located five meters from the edge of southbound York Street on the north side of the I-270/York Street interchange.

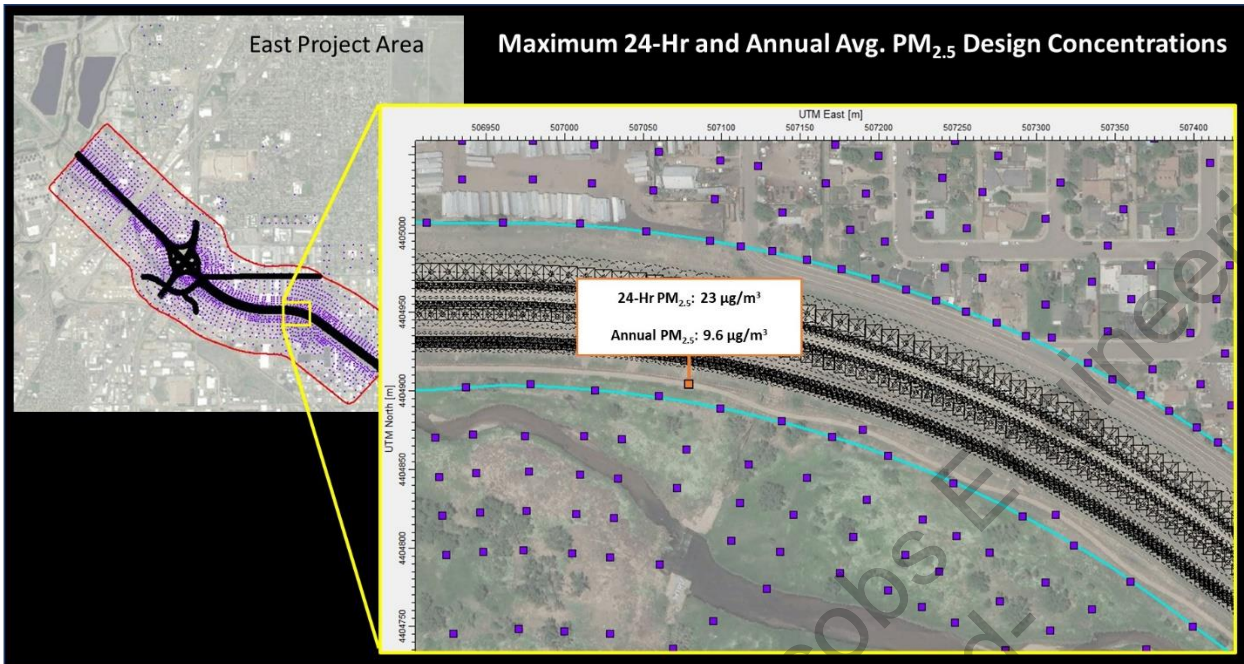

Figure 8. Location of receptor with the maximum 24-hr and annual average $PM_{2.5}$ design concentrations in the east project area. The receptor (orange square) is located within the ROW (indicated by the blue lines) on the Sand Creek Regional Greenway/Colorado Front Range Trail.

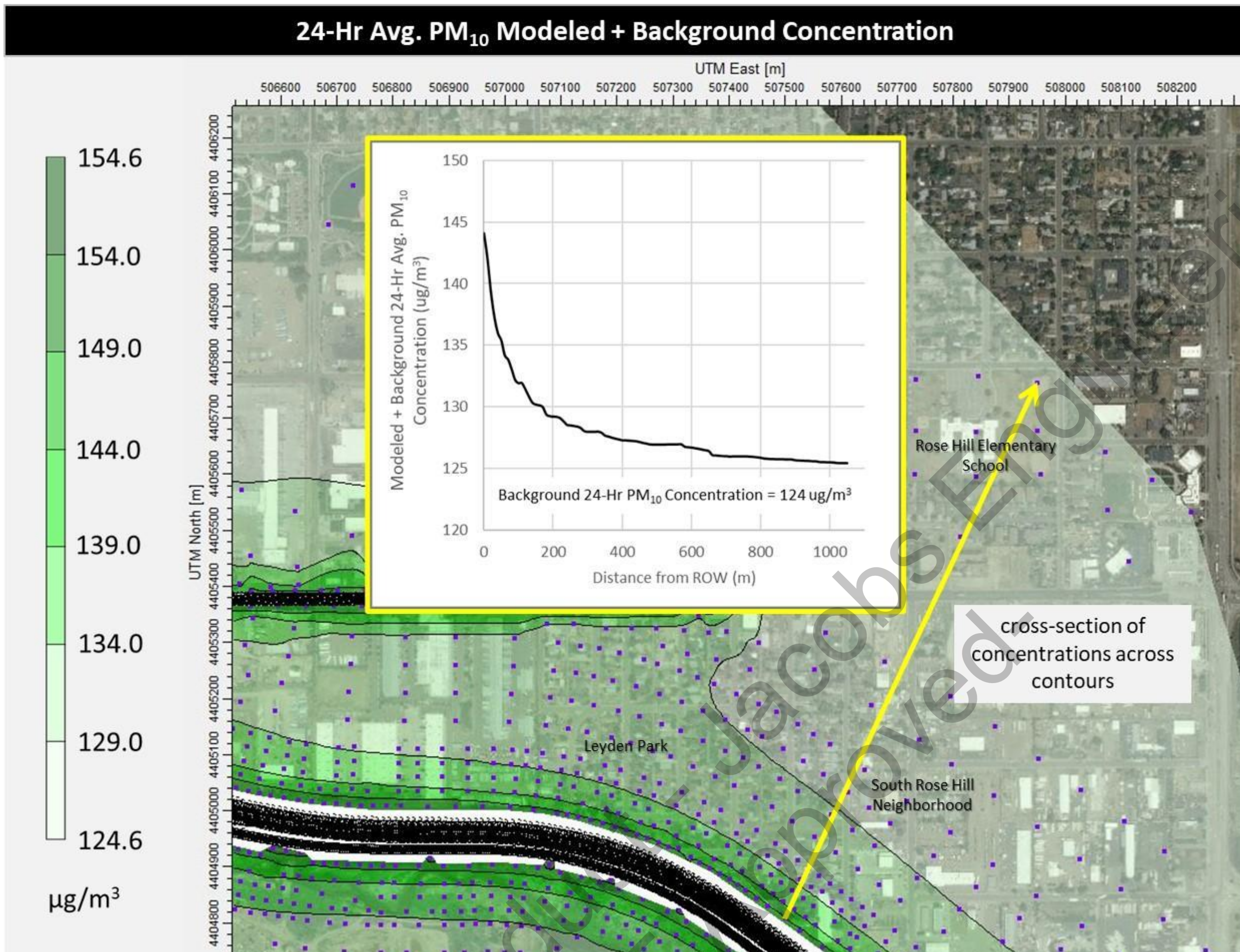

Figure 9. Illustration of drop-off in 24-hr average PM_{10} design concentrations (before rounding) with distance from modeled roadway sources in the east project area (note that concentration contours are based on interpolation using a triangulation method).

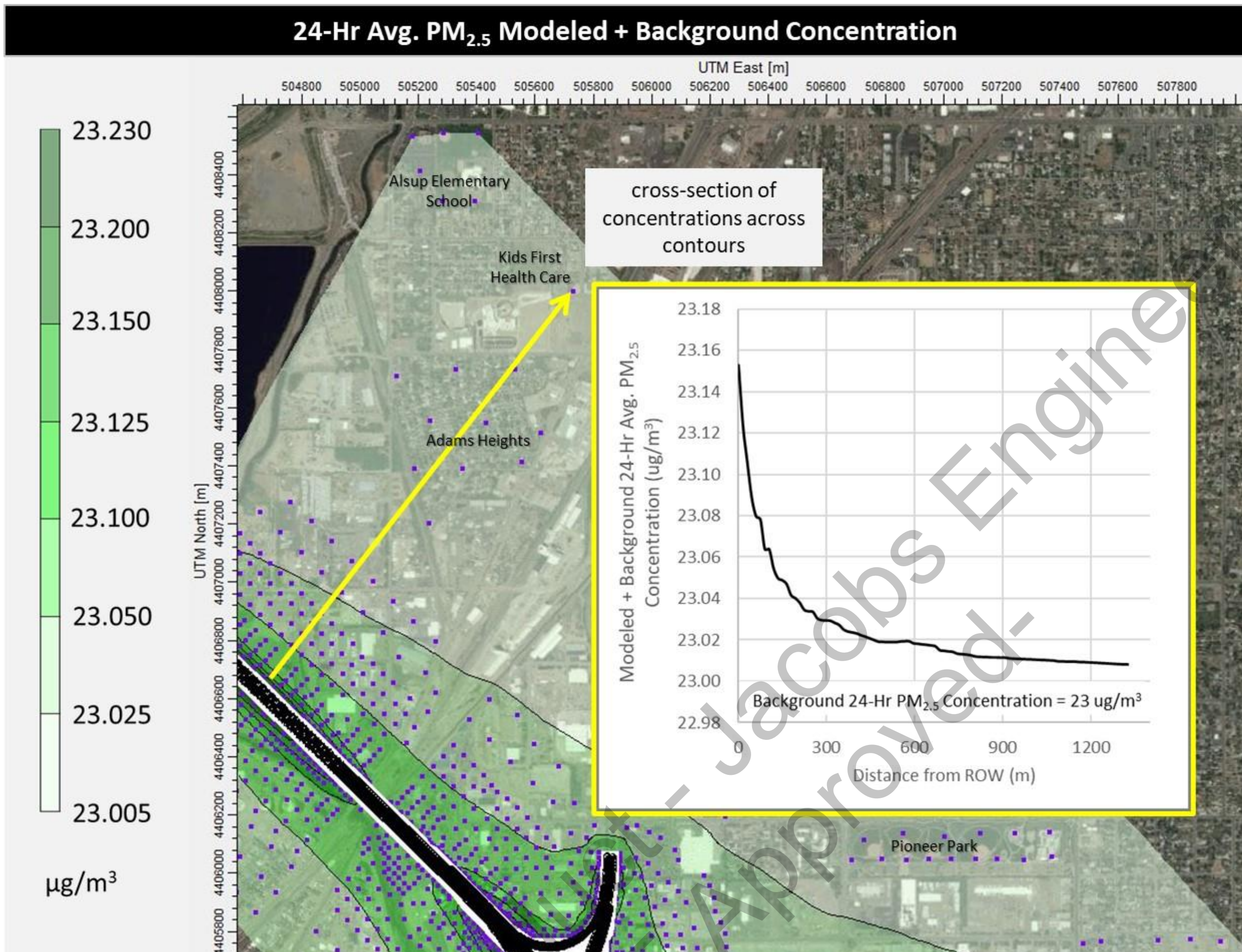

Figure 10. Illustration of drop-off in 24-hr average $PM_{2.5}$ design concentrations (before rounding) with distance from modeled roadway sources in the east project area (note that concentration contours are based on interpolation using a triangulation method).

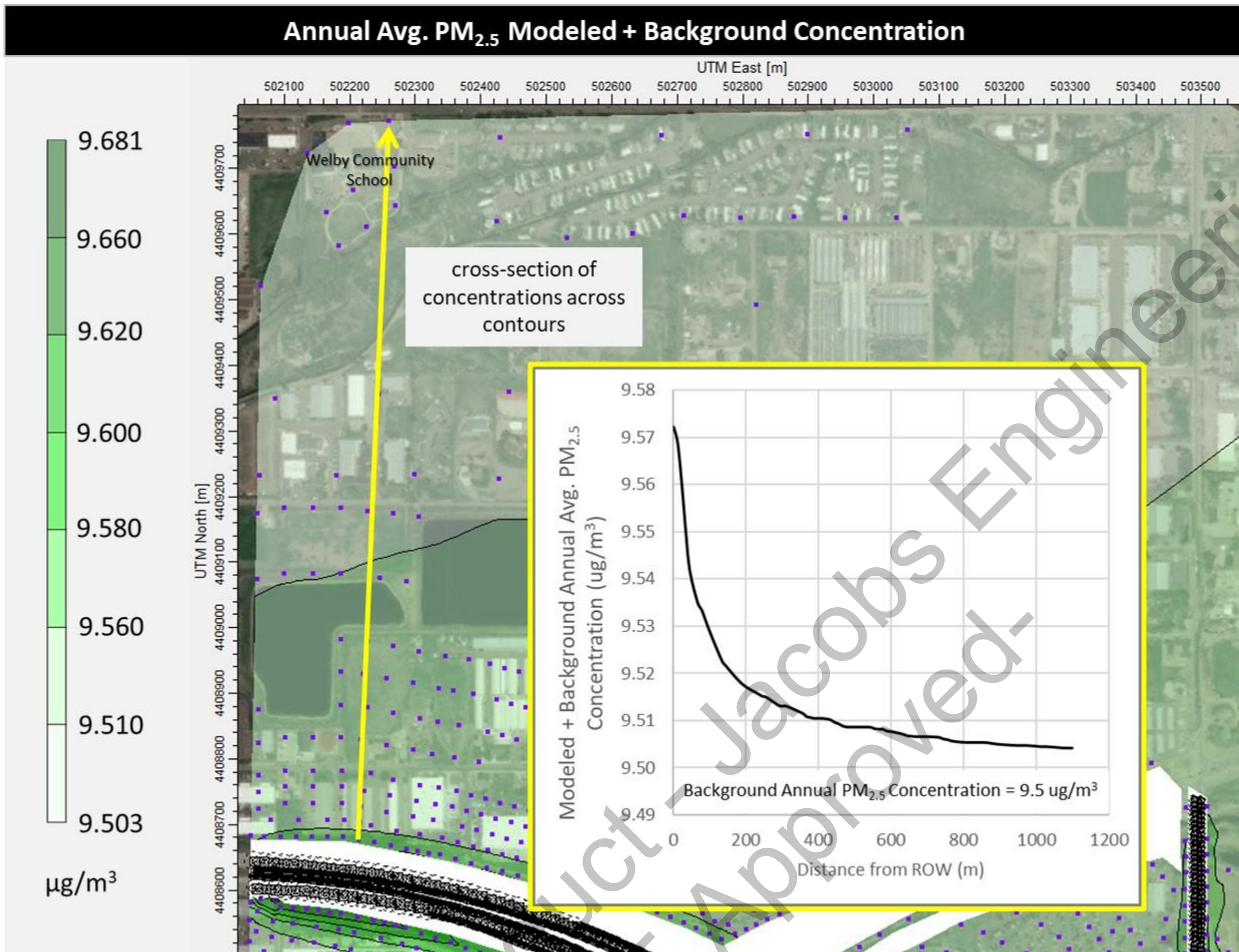

Figure 11. Illustration of drop-off in annual average $PM_{2.5}$ design concentrations (before rounding) with distance from modeled roadway sources in the west project area (note that concentration contours are based on interpolation using a triangulation method).

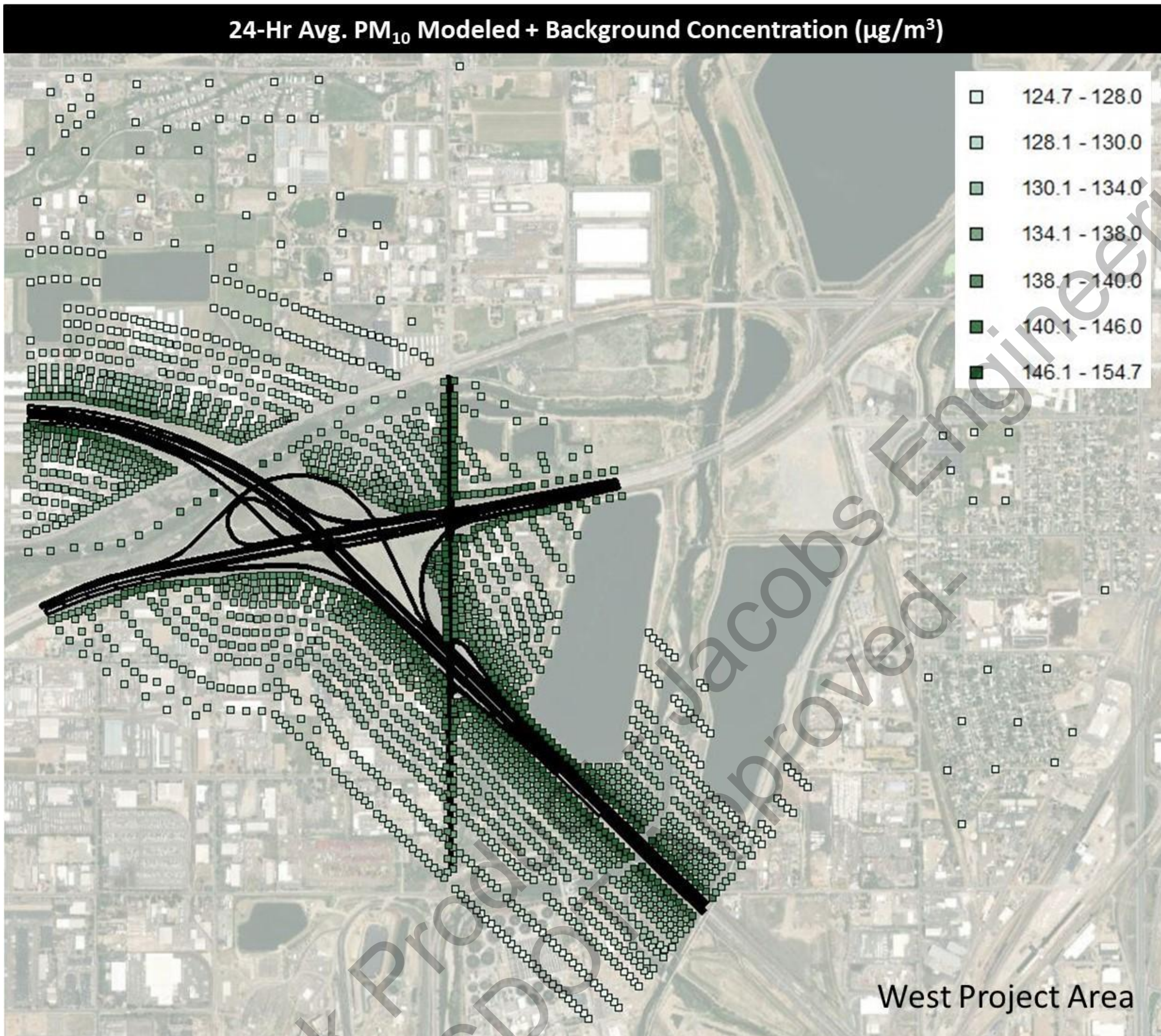

Figure 12. 24-hr average PM_{10} design concentrations (before rounding) at all receptors in the west project area. The background contribution to the design concentration is 124 µg/m^3.

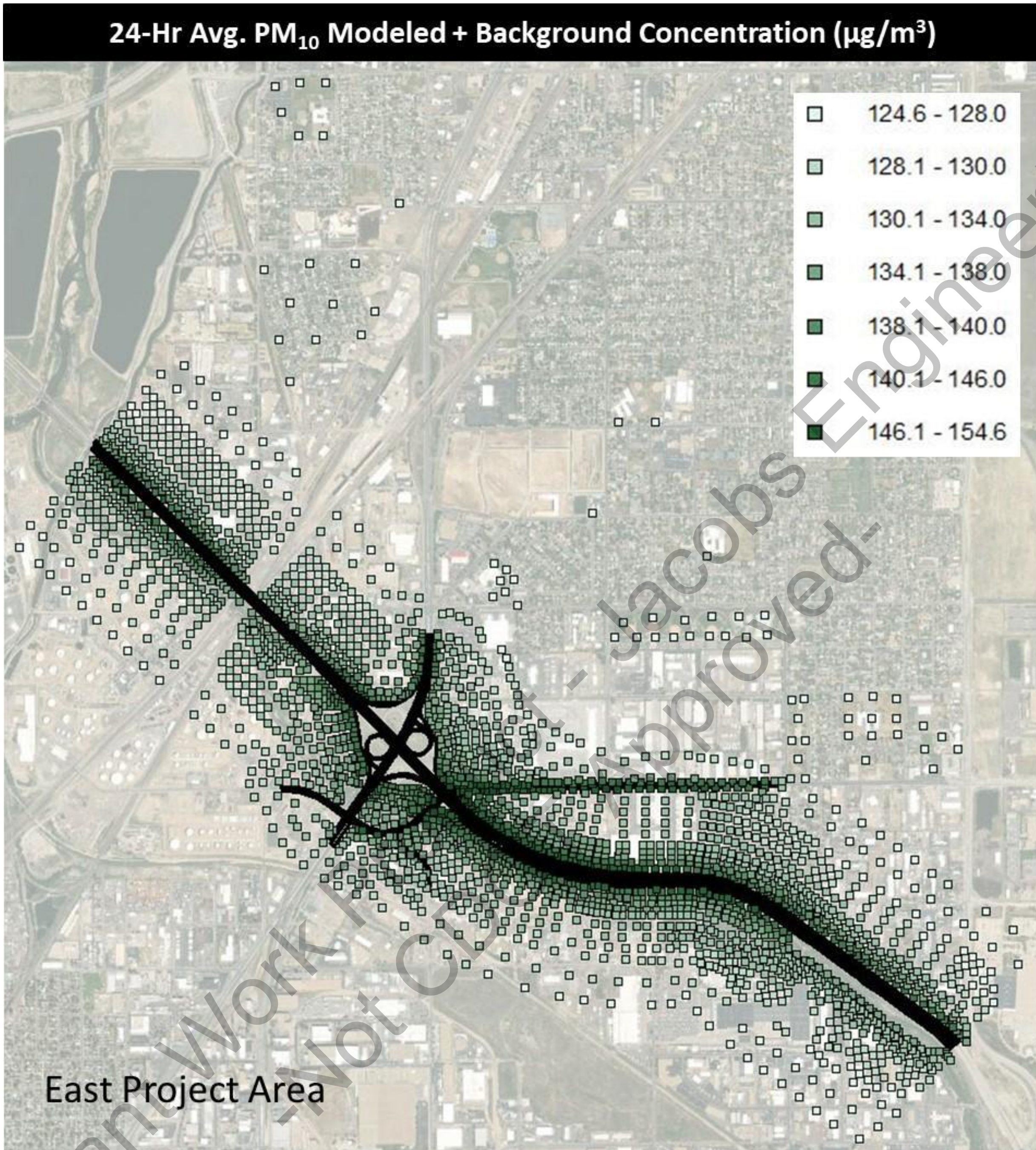

Figure 13. 24-hr average PM_{10} design concentrations (before rounding) at all receptors in the east project area. The background contribution to the design concentration is 124 µg/m³.

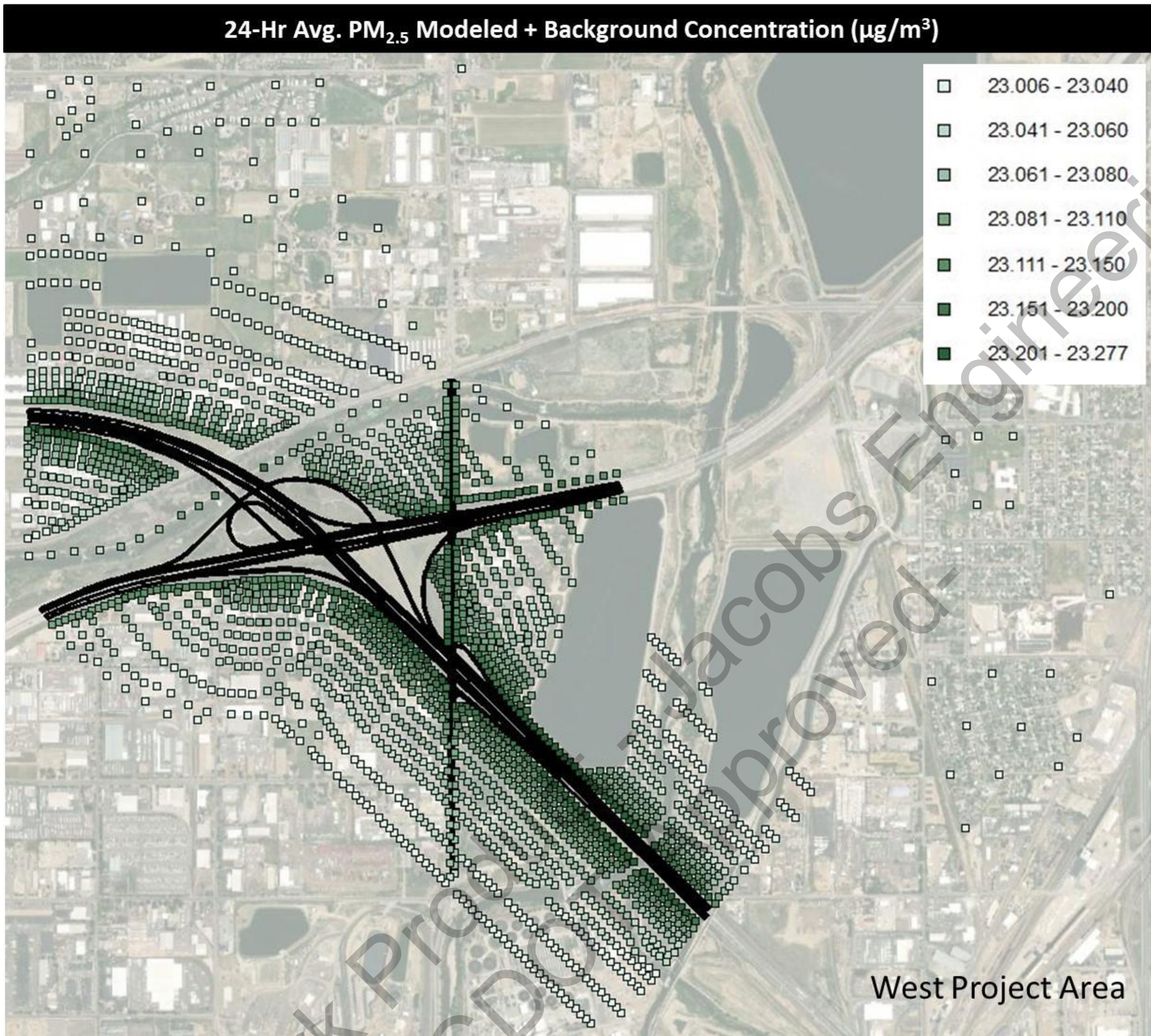

Figure 14. 24-hr average $PM_{2.5}$ design concentrations (before rounding) at all receptors in the west project area. The background contribution to the design concentration is 23 µg/m³.

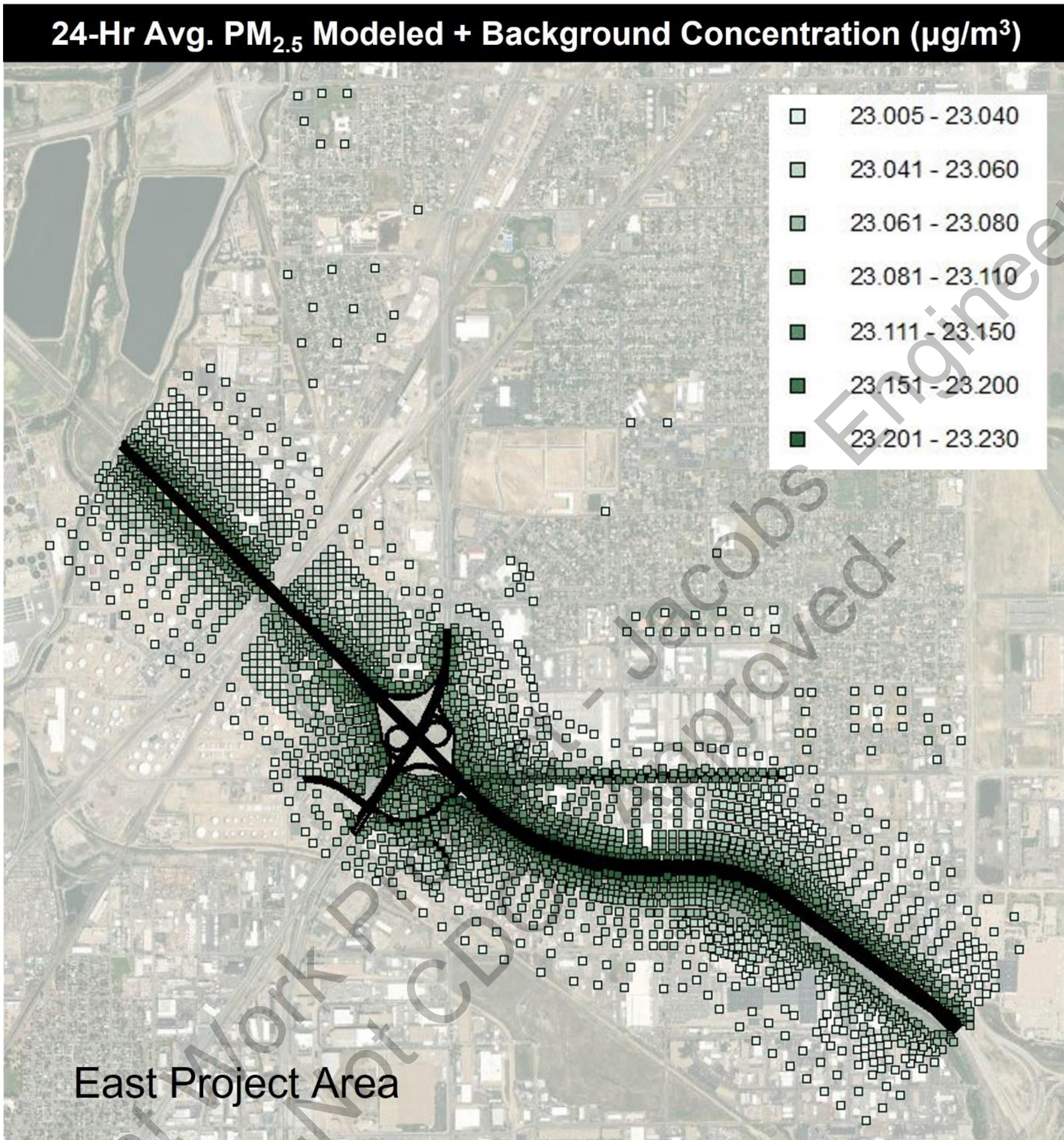

Figure 15. 24-hr average $PM_{2.5}$ design concentrations (before rounding) at all receptors in the east project area. The background contribution to the design concentration is 23 µg/m^3.

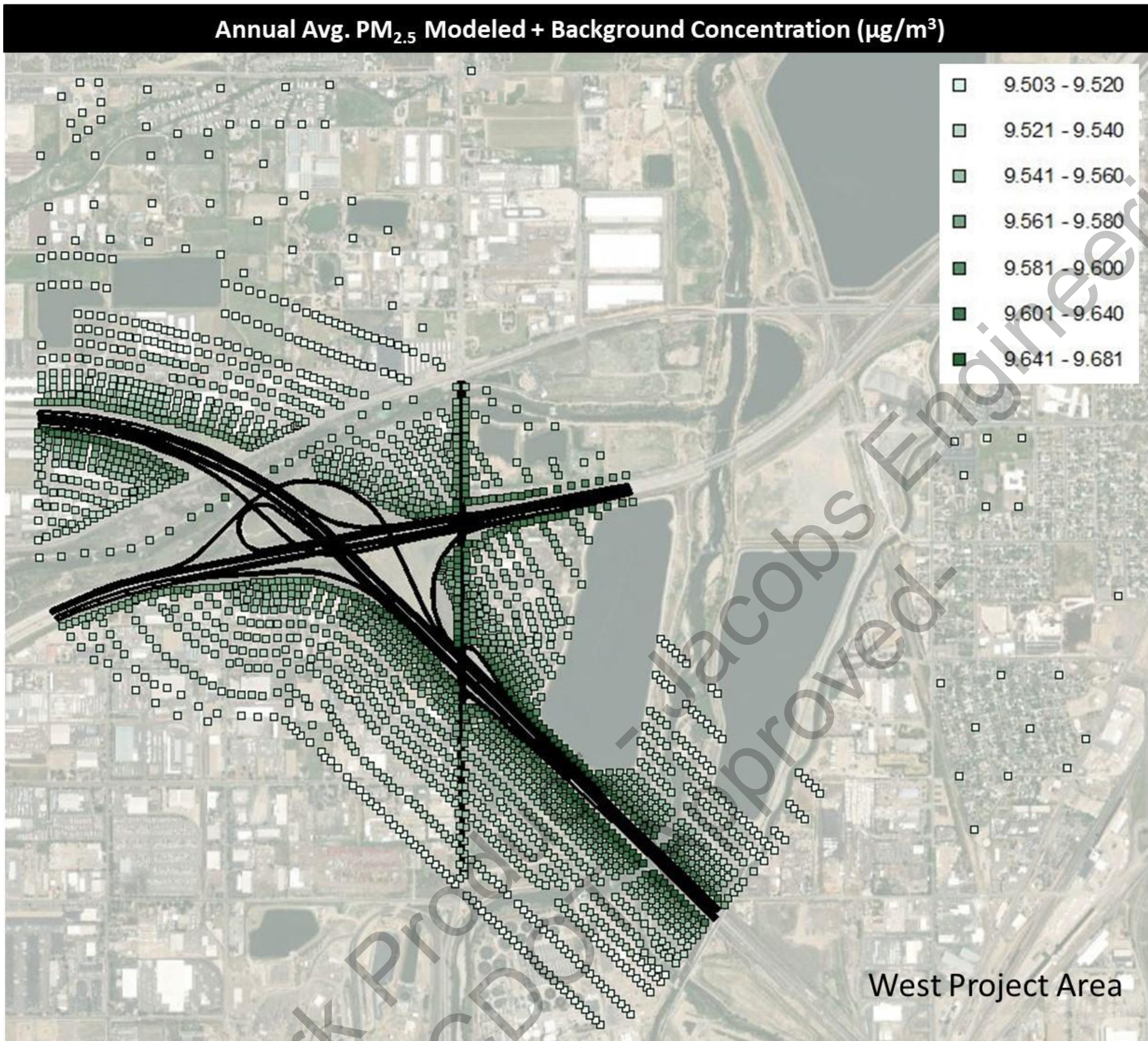

Figure 16. Annual average $PM_{2.5}$ design concentrations (before rounding) at all receptors in the west project area. The background contribution to the design concentration is 9.5 µg/m^3.

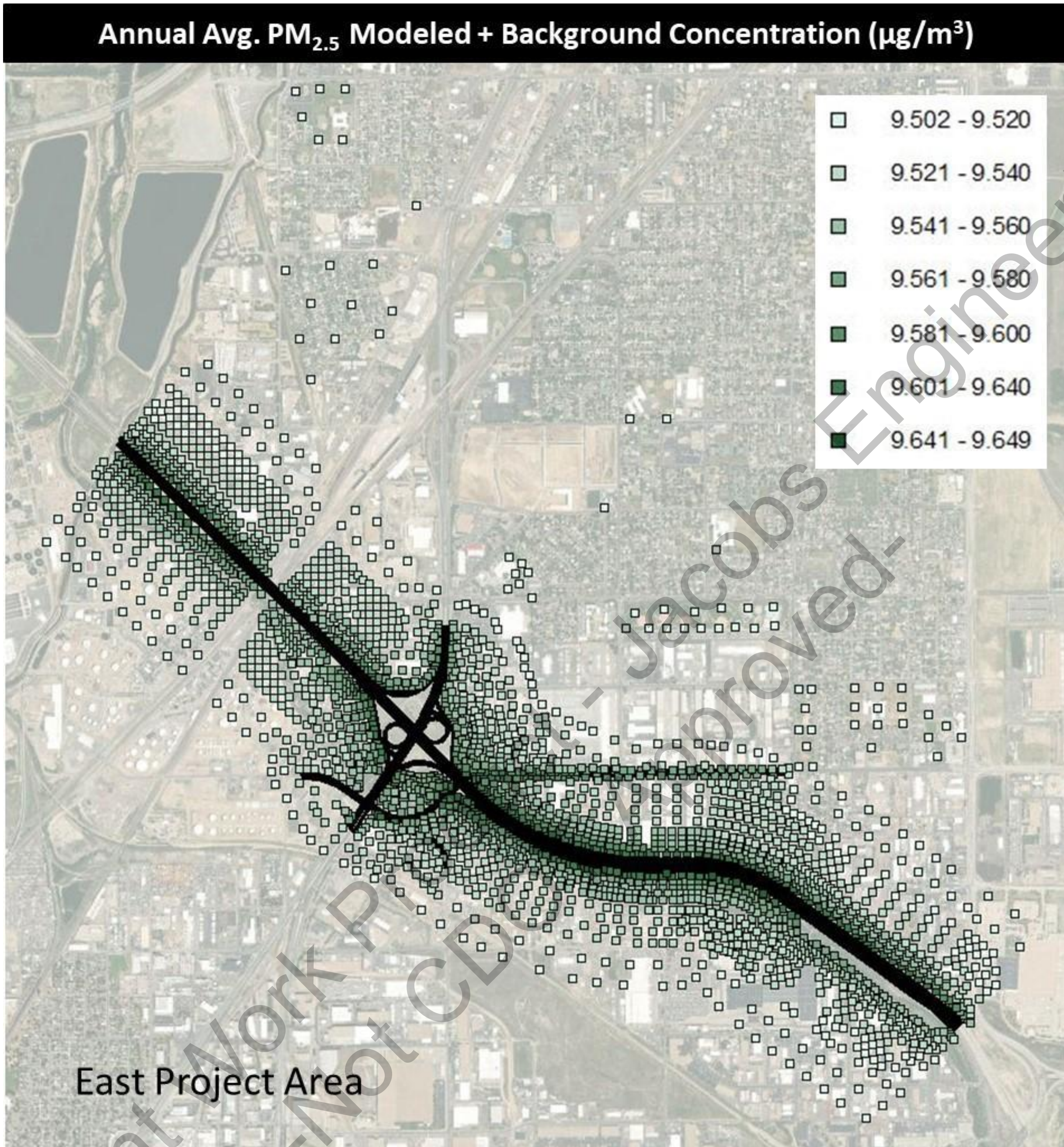

Figure 17. Annual average $PM_{2.5}$ design concentrations (before rounding) at all receptors in the east project area. The background contribution to the design concentration is 9.5 µg/m^3.

In conclusion, the PM modeling analysis shows that 24-hr average PM_{10}, 24-hr average $PM_{2.5}$, and annual average $PM_{2.5}$ design concentrations for the Proposed Action are less than or equal to the relevant NAAQS at all modeled receptors in both the west and east project areas.

7.0 References

Colorado Department of Public Health and Environment. 2005. *Colorado State Implementation Plan for PM_{10} Revised Technical Support Document*. September.

Colorado Department of Transportation (CDOT). 2019. *Air Quality Project-Level Analysis Guidance*. February. https://www.codot.gov/programs/environmental/air-quality/assets/cdot-aq-plag.

Liu, Shi V.; Chen, Fu-lin; Xue, Jianping. 2019. "A meta-analysis of selected near-road air pollutants based on concentration decay rates." *Heliyon.* Vol. 5, No. 8. August 23.

U.S. Environmental Protection Agency (EPA). 2021. *Transportation Conformity Guidance for Quantitative Hot-spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas*.

U.S. Environmental Protection Agency (EPA). 2014. *Near Roadway Air Pollution and Health: Frequently Asked Questions*.