



I-270 Corridor Improvements

State Air Quality Technical Report - I-270 Corridor Improvements Project

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Sonoma Technology conducted the air quality modeling and technical analyses for the I-270 Corridor Improvements Project, including modeling with the MOtor Vehicle Emissions Simulator (MOVES), CAL3QHC, and American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Dispersion Model (AERMOD). Sonoma Technology wrote all sections and appendices in this Air Quality Technical Report except for Sections 6.3 and 8 through 10, which were authored by specialists in the CDOT Air and Climate Section and Mobility Analysis Section.

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Acronyms and Abbreviations

Acronym	Definition
2GPL+1EL	Two General-Purpose Lanes and One Express Lane That Accommodates Transit
3GPL	Three General-Purpose Lanes
° F	degree(s) Fahrenheit
µg/m ³	microgram(s) per cubic meter
AADT	average annual daily traffic
APCD	Air Pollution Control Division
APEN	Air Pollutant Emission Notice
AQ-PLAG	<i>Air Quality Project-Level Analysis Guidance</i>
AQCC	Air Quality Control Commission
AQS	Air Quality System
C.R.S.	Colorado Revised Statutes
CAA	Clean Air Act
CCR	Code of Colorado Regulations
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFR	<i>Code of Federal Regulations</i>
CO	carbon monoxide
CRS	Colorado Revised Statutes
DEIS	Draft Environmental Impact Statement
DPM	Diesel Particulate Matter
DRCOG	Denver Regional Council of Governments
EA	Environmental Assessment
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FHWA	Federal Highway Administration
FR	<i>Federal Register</i>
GP	general-purpose
HAP	hazardous air pollutants
I-25	Interstate 25
I-270	Interstate 270
I-70	Interstate 70
I-76	Interstate 76
IRIS	Integrated Risk Information System
mph	miles per hour
MOVES	Mobile Source Vehicle Emissions Simulator
MPO	metropolitan planning organization
MSAT	mobile source air toxic

Acronym	Definition
MVRTP	Metro Vision Regional Transportation Plan
NAAQS	National Ambient Air Quality Standards
NASEM	National Academies of Science, Engineering, and Mathematics
NEPA	National Environmental Policy Act
NO ₂	nitrogen dioxide
NO _x	nitrogen oxides
O ₃	ozone
PAH	polycyclic aromatic hydrocarbons
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
POM	polycyclic organic matter
ppb	part(s) per billion (by volume)
ppm	part(s) per million (by volume)
ROW	Right-of-way
RS/TC	regionally significant transportation capacity
RTD	Regional Transportation District
RTP	Regional Transportation Plan
SIP	State Implementation Plan
SO ₂	sulfur dioxide
TIP	Transportation Improvement Program
USC	United States Code
VMT	vehicle miles traveled
VOC	volatile organic compound

1.0 Introduction

CDOT is dedicated to providing an accessible experience for everyone. While we are continuously improving our standards, some complex items in this document, such as certain figures and images, are difficult to create with fully accessible parameters to all users. If you need help understanding any part of this document, we are here to assist and have resources to provide additional accessibility assistance to any requests. Please email us at CDOT_Accessibility@state.co.us to request an accommodation, and a member of our I-270 Engineering Program will schedule a time to review the content with you. To learn more about accessibility at CDOT, please visit the [Accessibility at CDOT webpage on the CDOT Website](#).

1.1 Background

The Federal Highway Administration (FHWA) and Colorado Department of Transportation (CDOT) are preparing an Environmental Impact Statement (EIS) to evaluate potential improvements to the Interstate 270 (I-270) corridor (I-270 Corridor Improvements Project, or the Project). FHWA and CDOT are the lead agencies for the National Environmental Policy Act (NEPA) process, which was initiated in 2020, initially anticipating an Environmental Assessment. Moving into 2023, CDOT determined a more detailed environmental review was needed and requested that an EIS be prepared. A Notice of Intent was published in August 2024 (89 *Federal Register* [FR] 67510, FHWA 2024).

I-270 in Colorado is a controlled-access interstate highway with two through lanes in each direction between Interstate 25 (I-25) and Interstate 70 (I-70) in central Denver and Commerce City (Figure 1). It has a posted speed limit of 55 miles per hour (mph). The Project limits include the I-270 interchanges with Interstate 76 (I-76), York Street, Vasquez Boulevard, and Quebec Street. The Project would tie into the I-25 and I-70 system interchanges but improvements to these interchanges are part of projects on I-25 and I-70 that will be designed and approved separately.

The I-270 Corridor Improvements Project would implement transportation solutions that modernize the I-270 Corridor to accommodate existing and forecast transportation demands. The Project needs are:

- Traveler safety on the corridor,
- Travel time and reliability on the corridor,
- Transit on the corridor,
- Bicycle and pedestrian connectivity across I-270, and
- Freight operations on the corridor.

In addition to addressing Project needs, CDOT, FHWA, and Cooperating and Participating Agencies have established a key Project goal: to minimize environmental and community impacts resulting from the Project.

An air quality assessment including several analyses was conducted to estimate potential air quality impacts associated with the Project. A quantitative emissions inventory was

developed in accordance with specific requirements of Colorado Senate Bill (SB) 21-260 and Colorado Revised Statutes (C.R.S.) 43-1-128. Due to continued concerns about air quality in the I-270 area from the community and other stakeholders, CDOT committed to going above and beyond the C.R.S. 43-1-128 requirements and completing more detailed air quality analyses for the Project. Therefore, comparative hot-spot analyses were conducted for the main pollutants of concern: carbon monoxide (CO), particulate matter (PM) with diameter of 10 micrometers or less (PM₁₀), and PM with diameter of 2.5 micrometers or less (PM_{2.5}). Analyses governed by federal requirements are documented in a separate air quality technical report for the EIS.¹ The air quality assessment includes four key elements:

1. A quantitative emissions inventory for comparative analysis of criteria air pollutants (CAPs) and mobile source air toxics (MSATs).
2. A comparative CO hot-spot analysis for the worst-performing intersection, as affected by the Project.
3. Comparative PM hot-spot analyses for both PM₁₀ and PM_{2.5} in the Project area.
4. A qualitative discussion of potential emissions and air quality effects from construction activities.

The air quality analysis considered three Project alternatives:

1. No Action Alternative, which maintains the existing I-270 highway configuration of two general-purpose travel lanes in each direction.
2. Three General-Purpose Lanes Alternative (3GPL), which would add one general-purpose travel lane in each direction of I-270.
3. Two General-Purpose Lanes and One Express Lane That Accommodates Transit Alternative (2GPL+1EL), which would add one new travel lane, operated as an Express Lane, in each direction through the I-270 corridor.

¹ Requirements of federal law that are addressed under separate cover are available on the Project website at <https://www.codot.gov/projects/studies/i270study>.

Figure 1. I-270 Corridor Improvements Project Limits



1.2 Report Overview

This Air Quality Technical Report documents the air quality assessment that was conducted to meet state requirements and address input from the public and is prepared in accordance with the CDOT *Air Quality Project-Level Analysis Guidance (AQ-PLAG)* (CDOT 2019).

The report is organized as follows:

- Section 2 describes the resources considered in the analysis.
- Section 3 summarizes the regulations applicable to the analysis.
- Section 4 describes the affected environment and existing air quality conditions.
- Section 5 summarizes scoping and interagency consultation for the analysis.
- Section 6 provides an overview of the analysis methods.
- Section 7 summarizes the analysis results (environmental consequences).

- Section 8 discusses the travel demand modeling for the air quality analysis and the modeled changes in travel activity.
- Section 9 discusses CDOT's commitments for improving air quality by reducing regional background concentrations of $PM_{2.5}$.
- Section 10 presents CDOT's conclusions about the air quality analysis.

The scoping and interagency consultation activities for the Project culminated in the development of the Work Plan for this analysis. The Work Plan (Appendix A) and amendments to the Work Plan (Appendix B) provide methodology details in addition to those described in Section 6. These appendices are referenced in the report where relevant.

Sonoma Technology conducted the air quality modeling and technical analyses documented in this report and wrote all sections and appendices in the report except for Sections 6.3, and 8 through 10, which were authored by specialists in the CDOT Air and Climate Section and Mobility Analysis Section.

2.0 Resources Considered

The primary air quality concerns for the I-270 Corridor Improvements Project focus on the exposure of local populations to:

- Criteria pollutants that are regulated at the federal level through the Clean Air Act (CAA) (Title 42 United States Code [USC] Chapter 85) to achieve and maintain National Ambient Air Quality Standards (NAAQS) (40 Code of Federal Regulations [CFR] Part 50).
- MSAT pollutants defined by FHWA as priority MSAT pollutants of concern that arise from transportation activities.
- Fugitive dust emissions associated with Project construction activities.

The air quality analysis described in this report was conducted to address these concerns.²

2.1 Criteria Pollutants

The CAA of 1970, as amended, identifies six criteria pollutants that are harmful to human health and the environment. Ground-level ozone (O_3), CO, nitrogen dioxide (NO_2), PM_{10} , and $PM_{2.5}$ are considered transportation-related criteria pollutants. Nitrogen oxides (NO_x) and volatile organic compounds (VOC) are important transportation-related pollutant precursors.

Ground-level ozone. O_3 is a colorless gas that is formed when NO_x chemically reacts with VOCs in the presence of sunlight. Warm temperatures, strong sunlight, and low wind speeds provide optimum conditions for O_3 formation. O_3 concentrations often peak downwind of the NO_x and VOC emission sources. As a result, O_3 is of regional concern and O_3 pollution issues are addressed through regulation of NO_x and VOC emissions. O_3 is evaluated using VOC and NO_x emission precursors in an emission inventory burden analysis. VOCs are highly reactive hydrocarbons that contribute to O_3 formation. Motor vehicles produce NO_x and VOC emissions through combustion and also produce VOC emissions through fuel evaporative processes (known as running losses). O_3 can irritate and damage the respiratory system. Health effects

² A quantitative analysis of greenhouse gas (GHG) emissions is discussed in a separate technical report.

associated with O_3 include breathing problems, reduced lung function, asthma, and other respiratory ailments. O_3 also damages plants, trees, rubber products, fabrics, and other materials.

PM. PM is a complex mixture of small particles and liquid droplets classified as PM_{10} or $PM_{2.5}$. PM from motor vehicles is emitted directly from the tailpipe from fuel combustion (exhaust emissions) and is also produced from non-exhaust processes including brake wear, tire wear, road wear, and resuspended road dust. Construction activities also produce PM emissions through tailpipe exhaust and by disturbing dust (fugitive emissions). Diesel PM (DPM), an important MSAT of concern, is also a component of diesel vehicle exhaust. $PM_{2.5}$ penetrates deep into the lungs and can cause respiratory ailments and contribute to cardiovascular disease and increased mortality. PM_{10} does not penetrate as deep into the lungs but can irritate the nose and throat and cause respiratory distress.

CO. CO is a colorless, odorless gas emitted directly from vehicle tailpipes as a product of combustion. CO tends to concentrate at intersections with large traffic volumes, high vehicle delays, and poor level of service (high congestion). CO reduces the oxygen carrying capacity of blood in the body. High concentrations of CO can cause headaches, dizziness, and confusion, and can be hazardous to those with heart and respiratory issues. At very high concentrations, CO poisoning can cause unconsciousness and death.

Nitrogen dioxide. NO_2 is a highly reactive gas that is emitted during the combustion process. NO_2 can sometimes be seen as a reddish-brown haze layer over an urban area. Health effects include lung damage and respiratory illness. NO_2 is regulated through the NAAQS, but motor vehicles produce a variety of highly reactive nitrogen oxide pollutants, known collectively as NO_x , which cause health effects and also contribute to the secondary formation of O_3 and $PM_{2.5}$ in the atmosphere.

Sulfur dioxide. Sulfur dioxide (SO_2) is a highly reactive gas emitted during the combustion process. SO_2 also contributes to the secondary formation of $PM_{2.5}$ in the atmosphere. Motor vehicles emit very small amounts of SO_2 and related pollutants (known collectively as sulfur oxides, or SO_x) because diesel fuel contains sulfur, a natural component of crude oil. The U.S. Environmental Protection Agency (EPA) implements stringent regulations on the sulfur content in diesel fuel. Therefore, SO_2 is not considered a transportation-related criteria pollutant. SO_2 causes breathing problems and lung damage.

Lead. Lead (Pb) is a metal found naturally in the environment. It is used in manufacturing and historically was added to gasoline to reduce engine knocking, boost octane ratings, and decrease wear and tear on engine components. Pb poisoning causes serious health effects, including seizures, high blood pressure, learning disabilities, behavioral disorders, and central nervous system problems. Pb has been phased out of paint and automotive fuels and is no longer considered a transportation-related criteria pollutant.

The current NAAQS are shown in Table 1. The NAAQS include primary standards that protect public health and secondary standards that protect public welfare. Each NAAQS has a specific concentration level, averaging time, and statistical form.

Table 1. National Ambient Air Quality Standards

Pollutant	Primary/Secondary	Averaging Time	Level ³	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 µg/m ³	Not to be exceeded
NO ₂	Primary	1 hour	100 ppb	98th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Primary and Secondary	1 year	53 ppb	Annual mean
O ₃	Primary and Secondary	8 hours	0.070 ppm	Annual fourth-highest daily maximum 8-hour concentration, averaged over 3 years
PM _{2.5}	Primary	1 year	9 µg/m ³	Annual mean, averaged over 3 years
	Secondary	1 year	15 µg/m ³	Annual mean, averaged over 3 years
	Primary and Secondary	24 hours	35 µg/m ³	98th percentile, averaged over 3 years
PM ₁₀	Primary and Secondary	24 hours	150 µg/m ³	Not to be exceeded more than once per year on average over 3 years
SO ₂	Primary	1 hour	75 ppb	99th percentile of 1-hour daily maximum concentrations, averaged over 3 years
	Secondary	1 year	10 ppb	Annual mean, averaged over 3 years

2.2 Mobile Source Air Toxics

MSATs are hazardous air pollutants (HAP) emitted from motor vehicles and equipment that are known or suspected to cause cancer or other serious health and environmental effects. EPA has identified nine compounds with significant contributions from mobile sources that are among the key drivers of national and regional-scale cancer risk and noncancer hazards.

³ ppm: parts per million; µg/m³: microgram(s) per cubic meter; ppb: parts per billion

FHWA has labeled these as priority MSAT pollutants for NEPA studies. These priority MSAT pollutants are described below.⁴

1,3 Butadiene. 1,3 butadiene is a component of motor vehicle exhaust that breaks down quickly in the atmosphere but nonetheless is found in the ambient air at low levels in urban and suburban areas. Acute exposure causes irritation of the eyes, nasal passages, throat, and lungs. Chronic exposure may result in cardiovascular diseases, leukemia, and other cancers.

Acetaldehyde. Acetaldehyde is a component of motor vehicle exhaust. Acute exposure can result in irritation of the eyes, skin, and respiratory tract. Symptoms of chronic intoxication of acetaldehyde resemble those of alcoholism. Acetaldehyde is considered a probable human carcinogen.

Acrolein. Acrolein is a component of motor vehicle exhaust. Acute and chronic exposure may result in upper respiratory tract irritation and congestion, as well as irritation to the eyes. It is unclear from the scientific evidence if acrolein poses a reproductive or cancer risk to humans.

Benzene. Benzene is a component of gasoline vapors and motor vehicle exhaust. Acute (short-term) exposure can cause eye, skin, and respiratory tract irritation, while chronic (long-term) exposure can cause blood disorders, reproductive effects, and cancer.

DPM. DPM is a component of diesel exhaust that includes soot particles made up primarily of carbon, ash, metallic abrasion particles, sulfates, and silicates. More than 90 percent of DPM is less than 1 micrometer in diameter. DPM can increase the risk of cardiovascular, cardiopulmonary, and respiratory diseases, and lung cancer.

Ethylbenzene. Ethylbenzene is a component of gasoline vapors and motor vehicle exhaust. Acute exposure can result in respiratory effects, such as throat irritation and chest constriction, irritation of the eyes, and neurological effects such as dizziness. Chronic exposure has shown conflicting results regarding its effects on the blood.

Formaldehyde. Formaldehyde is a component of motor vehicle exhaust. Both acute and chronic exposure can result in respiratory symptoms, as well as eye, nose, and throat irritation. The EPA considers formaldehyde a probable human carcinogen.

Naphthalene. Naphthalene is a component of motor vehicle exhaust. Acute and chronic exposure can lead to anemia and cataracts, as well as liver and neurological damage. The EPA considers naphthalene a possible human carcinogen.

Polycyclic Organic Matter (POM). POM defines a broad class of compounds, including polycyclic aromatic hydrocarbons (PAH), which are formed by the incomplete burning of oil and gas and are present in the atmosphere in particulate and gaseous forms. POM compounds

⁴ These descriptions are informed by EPA's Health Effects Notebook for Hazardous Air Pollutants (<https://www.epa.gov/haps/health-effects-notebook-hazardous-air-pollutants>).

have various acute effects, but the principal concern is that chronic exposure can increase the risk of cancer in humans.

3.0 State and Local Regulatory Context

Several federal, state, and local laws and regulations are applicable to the consideration of a transportation project-level air quality assessment. As noted earlier, the air quality analyses documented in this report were conducted to meet state requirements or to voluntarily address public and stakeholder concerns about air quality. The state and local regulations applicable to the required analyses are described in this section.

3.1 Criteria Pollutants

The Colorado Air Pollution Prevention and Control Act of 1992 (CRS 25-7-101, or the Act) 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 Act requires the use of available practical methods to reduce, prevent, and control air pollution in the state. Colorado's Air Quality Control Commission (AQCC) oversees Colorado's air quality program.

The AQCC adopts air quality regulations to help ensure that Colorado meets clean air goals and requirements. Air quality regulations that impact Colorado transportation projects that have been adopted into the Code of Colorado Regulations (CCR) include, but are not limited to:

- Regulation Number 1 (5 CCR 1001-3): Emission Control for Particulate Matter, Smoke, Carbon Monoxide, and Sulfur Oxides - Construction Emissions Fugitive Dust Control
- Regulation Number 3 (5 CCR 1001-5): Stationary Source Permitting and Air Pollutant Emission Notice Requirements - Permitting Requirements for Land Development Projects
- Regulation No. 10 (5 CCR 1001-12): Criteria for Analysis of Transportation Conformity (Colorado's Conformity State Implementation Plan [SIP])
- Regulation No. 11 (5 CCR 1001-13): Motor Vehicle Emissions Inspection Program
- Regulation No. 12 (5 CCR 1001-15): Reduction of Diesel Vehicle Emissions
- Regulation No. 16 (5 CCR 1001-18): Street Sanding Emissions
- Regulation No. 20 (5 CCR 1001-24): Colorado Clean Cars and Trucks Regulation

3.2 Mobile Source Air Toxics

Toxic air pollutants, also known as HAPs, are those known to cause cancer or other serious health effects. The CAA Section 112 requires the EPA to regulate emissions of 188 HAPs. EPA assessed this expansive list in its rule on the Control of Hazardous Air Pollutants From Mobile Sources (72 FR, 8430, February 26, 2007) and identified a group of 93 compounds emitted from mobile sources that are part of EPA's Integrated Risk Information System (IRIS) (EPA 2021a). The EPA also identified a subset of this list that is now considered the nine priority MSATs: 1,3-butadiene, acetaldehyde, acrolein, benzene, DPM, ethylbenzene, formaldehyde, naphthalene, and POM (see Section 2.2). FHWA considers these to be the priority MSATs for

NEPA studies. This list is subject to change and may be adjusted in consideration of future EPA rules.

FHWA provides Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents (FHWA 2023a). FHWA guidance presents a tiered approach with three categories for analyzing MSAT in NEPA documents, depending on specific project circumstances for evaluating potential MSAT effects. CDOT has used FHWA guidance to inform air pollutant modeling conducted to meet state requirements in C.R.S. 43-1-128. Evaluation of potential MSAT effects from the Project following FHWA guidance are discussed further in Section 7.2 and Appendix F.

3.3 C.R.S. 43-1-128 and Transportation-Related Pollutants

SB 21-260 was signed on June 17, 2021, and requires the planning, funding, development, construction, maintenance, and supervision of a sustainable transportation system in Colorado. The State of Colorado works 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. SB 21-260 created C.R.S. 43-1-128, which includes additional requirements for CDOT and the Metropolitan Planning Organizations (MPOs) to engage in community involvement, modeling, and monitoring when assessing potential environmental impacts of regionally significant transportation capacity (RS/TC) projects. The requirements specific to an RS/TC project, as defined in Section 4 of C.R.S. 43-1-128, include the following:

- Use EPA-approved models to determine air pollutant emission impacts for the planned project. Provide monitoring and measurement of criteria pollutants prior to construction of the project.
- Develop and implement a PM construction plan to provide continuous monitoring and transparent public reporting of concentrations, issue public alerts as soon as possible when exceedance events occur, and implement action plans to address emission levels on construction projects prior to exceedances with a 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.

The I-270 Corridor Improvements Project is an RS/TC, and CDOT is required to use EPA-approved models to assess air pollutant emissions impacts during the environmental study process before construction begins (C.R.S. 43-1-128(4)(a)). Based on CDOT's March 31, 2023, guidance memo, "Interim Guidance for Project Level Compliance with 43-1-128 Draft," the transportation-related air pollutant emissions that need to be modeled for state purposes include: CO, NO₂, PM₁₀, PM_{2.5}, NO_x, VOCs, the nine priority MSAT listed in Section 3.2, and the greenhouse gases (GHGs) carbon dioxide (CO₂), methane (CH₄), and nitrous oxide (N₂O). As noted previously, the analysis of GHG emissions for the Project is discussed in a separate report.

4.0 Affected Environment

This section describes the atmospheric conditions of the study area, including the climate and topography, NAAQS attainment status, and monitored ambient pollutant concentrations.

4.1 Climate and Topography

The I-270 Corridor Improvements project is located in the Denver metropolitan area northeast of downtown Denver. The project resides in the South Platte River Valley, in the High Plains (elevation 5,150 ft above mean sea level) east of the Rocky Mountains. The region has a semi-arid, continental climate with hot summers and cold winters. The nearby mountains and surrounding hills produce microclimates that affect local wind and temperature patterns. The difference between the daily high and low temperatures in the project area can be extreme due to the high elevation and low relative humidity in the region. Summers are hot with high temperatures frequently exceeding 90 degrees Fahrenheit (°F). Winters are relatively cold with an average low temperature in December of 17.7°F (NWS 2021). The annual average precipitation in the Denver area is 14.5 inches, with 70 percent of the precipitation occurring during the summer months. The annual average snowfall is 54.8 inches, with most snow occurring from October to April. Downslope (Chinook) winds periodically bring warm and dry conditions, and in some cases, severe windstorms, to the region. Thunderstorms can occur within the study area during spring and summer.

4.2 Existing Air Quality

As of August 2025, all areas in Colorado were in attainment of all NAAQS criteria pollutants except ground-level O₃. Based on data reported by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD), the annual fourth-highest daily maximum 8-hour O₃ design values (DVs)⁵ have fluctuated above and below the NAAQS since 2008 (APCD 2024). Because O₃ is a regional air pollutant, it is not modeled at the project-level. However, the emission inventories developed for the I-270 air quality analysis include the O₃ precursor pollutants, NO_x and VOCs. The Denver region was previously designated nonattainment for CO and PM₁₀. It was redesignated to attainment/maintenance status for CO by the EPA on December 14, 2001 (EPA 2001), and for PM₁₀ by the EPA on September 16, 2002 (EPA 2002).⁶ Denver is in attainment for the 1997, 2006, and 2012 PM_{2.5} standards. In January 2025, APCD submitted a request to EPA that all areas of the state be designated attainment for the revised annual PM_{2.5} standard based on monitoring data from 2021-2023. EPA has not yet designated nonattainment areas for the 2024 annual PM_{2.5} standard of 9.0 µg/m³.

⁵ A design value is a statistic that describes the air quality status of a given location relative to the level of the NAAQS. Design values are used by EPA in comparison to the NAAQS for designating and classifying nonattainment areas.

⁶ The 20-year periods of maintenance with the CO and PM₁₀ NAAQS for the Denver-Boulder area ended on January 14, 2022, and October 16, 2022, respectively.

APCD operates several EPA-approved air pollutant monitoring stations in Adams County and the City and County of Denver. Ambient air quality monitoring data from stations near the Project that best represent the study area are provided for 2020-2024 in Table 2. The monitor closest to the Project is located at 7275 Birch St. in Commerce City (Commerce, Air Quality System [AQS] 080010010),⁷ approximately 1.3 miles northeast of the I-270/York St. interchange, and is considered to be most representative of the air quality conditions of the study area. The Commerce City monitor measures only PM₁₀ and PM_{2.5} concentrations. Air quality data for other pollutants in Table 2 were obtained from a nearby station located at 3174 East 78th Avenue in Welby (Welby, AQS 080013001), approximately 1.3 miles north-northeast of the I-270/York St. interchange.

Table 2. Pollutant Concentrations Measured at Air Quality Monitoring Sites Near the Project Site¹

Site	Pollutant	Parameter	2020	2021	2022	2023	2024
Commerce ²	PM ₁₀	Maximum 24-hour average (µg/m ³)	139	104	114	98	142
Commerce	PM _{2.5}	98th percentile 24-hour average (µg/m ³)	27.8	29.8	16.4	23.7	21.5
Commerce	PM _{2.5}	Annual average (µg/m ³)	9.8	10.3	6.9	8.3	7.1
Welby	PM ₁₀	Maximum 24-hour average (µg/m ³)	111	96	100	95	139
Welby	CO	Maximum 1-hour average (ppm)	1.9	2.0	2.0	1.8	NA ³
Welby	CO	Maximum 8-hour average (ppm)	1.2	1.5	1.1	1.3	NA
Welby	O ₃	3-year average of fourth max. 8-hour (ppm)	0.069	0.072	0.077	0.074	0.076
Welby	NO ₂	3-year average of 98th percentile 1-hour (ppb)	60	58	56	56	55
Welby	NO ₂	Annual average (ppb)	15.5	15.4	16.7	15.9	14.4

¹ Data in Table 2 were obtained from APCD Network Monitoring Plans (APCD 2021, 2022, 2023, 2024, and 2025).

² The Commerce monitoring site was closed on November 2, 2020, and relocated to Birch Street, where monitoring resumed in March 2021. As a result, the concentrations listed for this monitoring site for calendar years 2020 and 2021 are based on incomplete datasets.

³ Monitored CO concentrations are not available (NA) at the Welby site for the year 2024; CO monitoring at this site was discontinued in October 2023.

The Colorado ambient air monitoring network operates in accordance with federal requirements outlined in 40 CFR Part 58, including Appendices A, C, D, and E, which govern instrument performance, data quality assurance, network design, and siting criteria. Routine audits of particulate analyzers are conducted quarterly, and gaseous analyzers are audited twice annually (APCD 2025). Exceptions to routine monitoring sometimes occur due to relocations, equipment issues, or other operational constraints; for example, the Commerce

⁷ The Commerce City monitor was located at 4201 72nd Avenue through 2020, and was then switched to the current location on Birch Street. During the switch, no data were collected between November 2020 and the first half of March 2021. Therefore, calendar years 2020 and 2021 do not have complete data at the Commerce City monitor.

City monitoring site was closed in November 2020 and resumed operations at Birch Street in March 2021, resulting in incomplete datasets for 2020 and 2021 at that location. Additionally, CO monitoring at the Welby site was discontinued in October 2023 as documented in APCD's annual network monitoring plans.

5.0 Project Scoping and Interagency Consultation

5.1 Project Scoping

An environmental scoping meeting was held for the Project on September 20, 2023. FHWA, CDOT resource specialists and Project staff, and consultant team members were invited to the meeting. The meeting included the topics of Project overview and status; roles, responsibilities, and expectations; agency coordination; and a review of the environmental resources and scoping form. It was not determined that additional air quality scoping meetings were necessary at the meeting.

Additionally, extensive in-person and virtual engagement opportunities were conducted by CDOT for the EIS Project scoping. Public outreach began in early 2023 and concluded on October 31, 2024, at the end of the official NEPA scoping period. During Project scoping, the Project team received numerous comments from the public and other stakeholders who were concerned that the Project might negatively impact air quality in the area. These concerns helped shape the air quality analysis process, and CDOT committed to going above and beyond regulatory requirements. To help alleviate concerns about potential air quality impacts from the Project, CDOT included CO, PM₁₀, and PM_{2.5} hot-spot modeling in the analysis.

5.2 Interagency Consultation

Numerous Air Quality Working Group meetings were held throughout the process of conducting the air quality analysis for the Project and included invitees from FHWA, EPA, CDOT, and the consultant team. Initially, Working Group meetings were held weekly to discuss analysis needs and development of the Work Plan; then, meetings were held as needed to continue coordination and discuss analysis results.

The Air Quality Work Plan was reviewed by FHWA, EPA, and CDOT, and consensus was reached to complete the final approved Work Plan, dated July 11, 2024. Some changes to the Work Plan were made as the analysis unfolded. The changes and reasons for them were discussed and approved in Air Quality Working Group meetings and documented in the administrative record for the Project. These Work Plan amendments are described in Appendix B.

Inputs to the various models for the air quality analysis were sent out for review and comments discussed at the meetings. Inputs were revised as necessary and used to set up the models. Inputs included data such as emissions factors, traffic information, construction durations, and source and receptor layouts for hot-spot modeling.

Once the analysis results were available and quality checked, they were presented to and discussed with the Working Group participants. Questions and comments from the Working

Group were addressed as necessary by updating inputs for the analysis to more accurately reflect available data and information about the study area for the Project.

6.0 Methods Overview

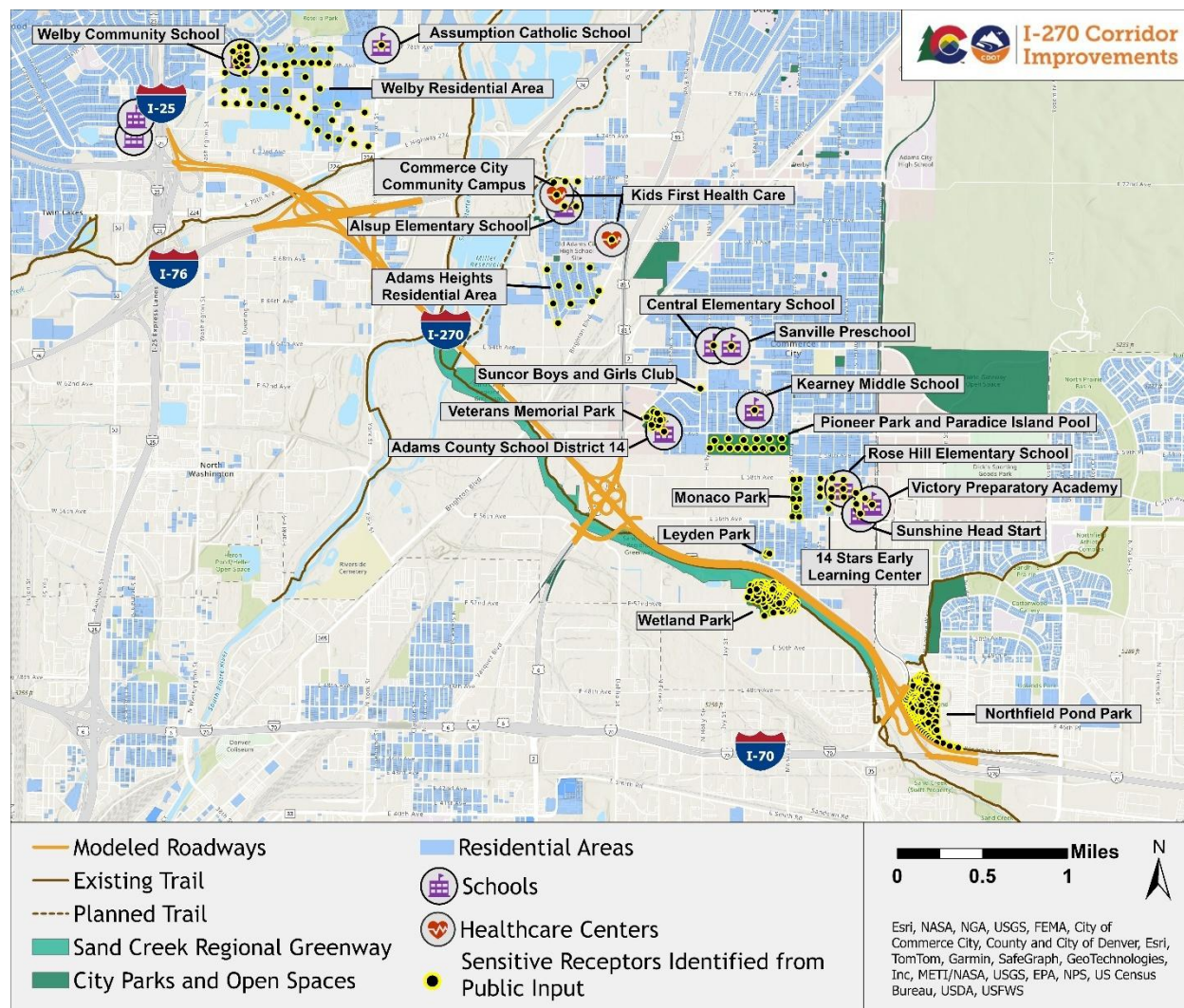
All elements of the air quality analysis were completed based on the requirements of CDOT's AQ-PLAG, Version 1 (CDOT 2019). The Work Plan and its amendments (Appendices A and B) briefly describe the methodology used for all elements of the analysis. Appendix C provides details about the methods used to develop the quantitative emission inventories for operational emissions from motor vehicles using the most recent version of EPA's Motor Vehicle Emissions Simulator (MOVES) model (MOVES4.0.1) when the analysis was conducted. The emission inventories were calculated for the 2023 Existing Conditions and each Project alternative in the design year (2050). Appendix D provides details about the CO hot-spot modeling that was performed with the EPA CAL3QHC model to compare estimates of CO concentrations associated with worst-case impacts of the Project alternatives. Appendix E provides details about the PM hot-spot modeling that was conducted with the American Meteorological Society/EPA Regulatory Model Improvement Committee (AERMIC) Dispersion Model (AERMOD) to estimate and compare estimates of PM₁₀ and PM_{2.5} concentration impacts from the Project Alternatives.

6.1 Study Area

The air quality analysis for the I-270 Corridor Improvements Project encompasses a comprehensive study area that includes the entire approximately 6.5-mile stretch of I-270 between I-25 and I-70, as well as other roadways and intersections that are part of or impacted by the Project (Figure 2).⁸ The Project limits include the I-270 interchanges with I-76, York Street, Vasquez Boulevard, and Quebec Street. 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 study area spans portions of Adams County and Denver County, and the air quality analysis focuses on the roadways colored orange in Figure 2.⁹

⁸ Impact of the Project build alternatives refers to changes in AADT on traffic links that connect with a project roadway and are within 100 meters of the Project. Relevant changes in AADT are based on thresholds defined in FHWA guidance (FHWA 2023b).

⁹ The roadways and roadway segments included in the air quality analysis shown in Figure 2 explicitly represent those in the No Action Alternative. For the Project build alternatives, the analysis includes roadways corresponding to the additional lanes on I-270 and reconfigured ramps and intersections.

Figure 2. Air Quality Study Area


6.2 Sensitive Receptors

Children, the elderly, and those with health conditions that make them most susceptible to the adverse effects of exposure to air pollution are generally considered to be sensitive to air pollutants compared with other individuals. Sensitive air quality receptors can include residences, schools, day care centers, parks and playgrounds, elder care facilities, and hospitals. The I-270 project is located in an urban area with land uses that are mostly industrial, along with commercial and residential areas. There are also public trails and green spaces near I-270 where the public may congregate or recreate.

Below is a list of sensitive receptors in the vicinity of the Project area that were identified from public input on the Project.

- Welby Community School
- Assumption Catholic School
- Welby and Other Residents

- C4 Campus
- Alsup Elementary School
- Kids First Health Care
- Adams 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 Paradise 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

6.3 Description of Alternatives

The air quality analysis considered two Project build alternatives for full evaluation, as well as the No Action Alternative, which is fully evaluated as a baseline for comparison. Additional information on the development of project alternatives and evaluation process for the build alternatives are included in the *I-270 Corridor Improvements Project Environmental Impact Statement Alternatives Development Technical Report*.

6.3.1 No Action Alternative

The No Action Alternative evaluates operations of I-270 if a build alternative did not occur along the corridor. It does not address the Project purpose and needs but serves as a baseline for comparison. This alternative would maintain the existing highway configuration of two GP travel lanes in each direction. Under the No Action Alternative, the corridor would require substantial ongoing maintenance and continuous repairs to bridges and pavement. While these frequent maintenance activities would be necessary to keep the roadway operational, they would lead to recurring lane closures, traffic disruptions, and temporary impacts to travel time and reliability. Furthermore, the underlying infrastructure deficiencies would persist, necessitating increasingly complex and potentially impactful repairs over time.

The No Action Alternative would include the rehabilitation of 19 existing structures, including those at 7 locations that have structures that are or will be reaching the end of their useful life. The age of the structure, recent bridge inspections, and current ongoing maintenance costs, both planned and emergency maintenance, determine whether a structure is or will be reaching the end of its useful life. The seven structure locations along the I-270 corridor that are or will be reaching the end of their useful life are as follows:

- Vasquez Bridge over Sand Creek
- York Street Bridge over I-270
- I-270 over South Platte River Eastbound and Westbound Bridges
- I-270 over Burlington Ditch Eastbound and Westbound Bridges
- I-270 over Brighton Boulevard, Union Pacific Railroad (UPRR) and BNSF Railway (BNSF) Eastbound and Westbound Bridges
- I-270 over 60th Avenue and BNSF Eastbound and Westbound Bridges
- I-270 over East 56th Avenue Eastbound and Westbound

The cross section would remain unchanged along I-270 under the No Action Alternative. Figure 3 shows the No Action Alternative cross section west of Vasquez Boulevard, and Figure 4 shows the cross section east of Vasquez Boulevard.

Figure 3. No Action Alternative (west of Vasquez Boulevard)

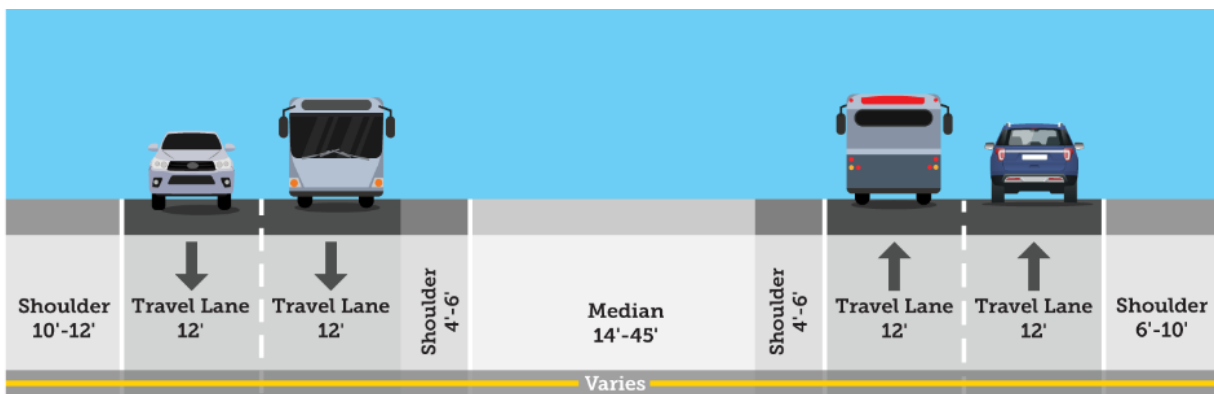
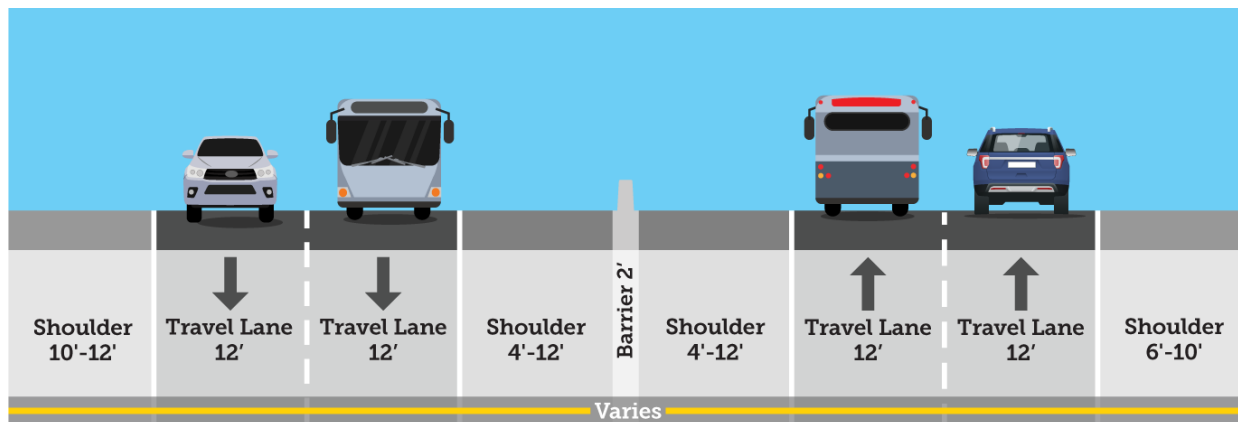


Figure 4. No Action Alternative (east of Vasquez Boulevard)



6.3.2 Build Alternatives

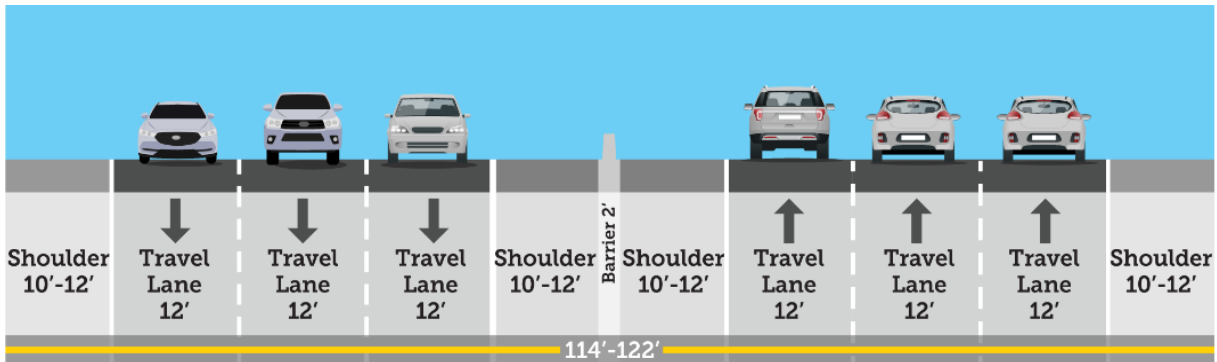
The build alternatives include improving the operational and physical conditions of the I-270 highway; reconfiguring interchanges and ramps; enhancing transit on the corridor; improving bicycle and pedestrian access across I-270; replacing deficient bridges and other infrastructure; and providing modern drainage, water quality, intelligent transportation systems (ITS), and other supporting infrastructure. Both add one new travel lane in each

direction and have similar footprints. They differ primarily in how the additional travel lane operates.

6.3.3 Three General-Purpose Lanes Alternative

This alternative would reconstruct I-270 to provide three GP lanes in each direction, as shown in Figure 5.

Figure 5. Three General-Purpose Lanes Alternative



This alternative includes:

Mainline Improvements

- Providing three GP lanes in each direction.
- Widening shoulders to meet standard requirements.
- Restriping of the westbound I-270 to northbound I-25 off-ramp to provide dual-exit lane capacity.
- Adding emergency turnouts and turnarounds.
- Adding one continuous auxiliary lane in each direction between the I-76 and Vasquez Boulevard on-ramps and off-ramps.

Interchange Improvements

- Redesigning the I-270 on-ramps and off-ramps at I-76, York Street, Vasquez Boulevard, and Quebec Street to provide adequate acceleration and deceleration lanes to meet design standards and address safety issues along the corridor.
- Consolidating the I-76 off-ramps to eastbound I-270 to merge onto I-270 at a single location.
- Separating the westbound I-76 and York Street shared exit to provide two separate exit ramps.
- Reconfiguring the Vasquez Boulevard interchange to a partial cloverleaf, including the addition of a northbound Vasquez Boulevard to eastbound I-270 on-ramp.

Bridge Improvements

- Reconstructing bridges that are at or will be reaching the end of their useful life.

- Replacing the existing York Street Bridge over I-270 to meet bridge standards, accommodate an additional travel lane in each direction, a 10-foot multi-use path, a 5-foot sidewalk, and enhanced lighting.
- Replacing the existing I-270 bridges over the South Platte River Trail to meet bridge standards, accommodate this project's bicycle and pedestrian improvements on the South Platte River Trail, as well as enhanced lighting.
- Replacing the existing I-270 bridges over the Burlington Ditch to meet bridge standards, accommodate future bicycle and pedestrian improvements, as well as enhanced lighting.
- Replacing the existing I-270 bridges over Brighton Boulevard to meet bridge standards and accommodate this project's bicycle and pedestrian improvements on Brighton Boulevard and future bicycle and pedestrian improvements, as well as enhanced lighting.
- Replacing the existing I-270 bridges over East 60th Avenue and BNSF Railroad Crossing to meet bridge standards and accommodate future bicycle and pedestrian improvements, as well as enhanced lighting.
- Replacing the existing I-270 bridges over East 56th Avenue to meet bridge standards, accommodate this project's bicycle and pedestrian improvements, as well as enhanced lighting.
- Replacing the existing Vasquez Boulevard bridge over Sand Creek to meet bridge standards and accommodate this project's bicycle and pedestrian improvements.

Bicycle and Pedestrian Enhancements

- Improving the York Street I-270 ramp terminal intersections with added crosswalks, curb ramps, and pedestrian indicators at the ramp terminal traffic signals.
- Adding a new 5-foot sidewalk on the west side and reconstructing a 6-foot sidewalk on the east side of Brighton Boulevard under I-270.
- Reconstructing East 56th Avenue under I-270 and adding an on-street bicycle lane, a 10-foot, and 6-foot sidewalk connecting to existing sidewalks.
- Improving the intersection at East 56th Avenue and South Sandcreek Drive to include ADA-compliant curb ramps, crosswalks, and enhanced lighting.
- Improving the intersection at East 56th Avenue and Eudora Street to include ADA-compliant curb ramps, crosswalks, and enhanced lighting.
- Adding attached sidewalks on the west side of South Sandcreek Drive. The new sidewalks would be 8 feet wide from Quebec Street to East 47th Avenue Drive and 6 feet wide from East 47th Avenue Drive to East 49th Avenue, with a pedestrian crosswalk across East 47th Avenue Drive connecting the two segments.
- Improving wayfinding at key locations to guide bicyclists and pedestrians to the nearest RTD bus stops and major road connections, or provide distances to the next trailhead and to avoid out-of-direction travel.

Trail Enhancements

- Reconfiguring the South Platte River Trail crossing under I-270 to improve bicycle and pedestrian visibility around tight curves and increase vertical clearance from the I-270 overpass.
-

- Improving bicycle and pedestrian visibility on the Sand Creek Trail by straightening out tight curves, adding a center stripe, and enhancing lighting at the Vasquez Boulevard bridge over the Sand Creek Trail.
- Adding a multi-use path with bicycle and pedestrian underpasses crossing under two free-flow interchange ramps on the east side of Vasquez Boulevard through the interchange with enhanced lighting.
- Adding a multi-use path on the east side of the Vasquez Boulevard Bridge over Sand Creek to connect users from the East 56th Avenue and Vasquez Boulevard intersection to a new connection to the Sand Creek Trail.
- Adding a multi-use path on the west side of the Vasquez Boulevard Bridge over Sand Creek to connect users from the East 56th Avenue and Vasquez Boulevard intersection to a new connection to the Sand Creek Trail.
- Adding a multi-use spur to connect the proposed north-south Vasquez Boulevard multi-use trail to the East 56th Avenue and South Sandcreek Drive intersection.
- Adding a multi-use path in the southeast corner of East 56th Avenue and South Sandcreek Drive.
- Adding a 10-foot-wide bicycle and pedestrian overpass over I-270 and South Sandcreek Drive approximately halfway between East 56th Avenue and Quebec Street.

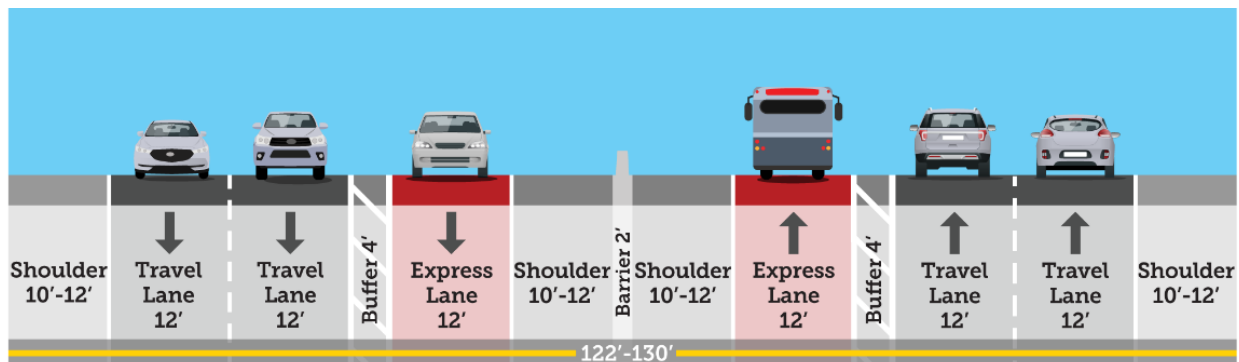
Transit Enhancements

- Adding bus stops at Quebec Street and South Sandcreek Drive to improve access to RTD routes 88 and 37.

6.3.4 Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative

This alternative would reconstruct I-270 with two GP lanes and one EL in each direction, as shown in Figure 6. Transit vehicles and high-occupancy vehicles (three or more people) could travel in the EL free of charge. Other travelers, including freight trucks, could pay a fee to use the new EL.

Figure 6. Two General-Purpose Lanes and One Express Lane that Accommodates Transit Alternative



This alternative includes:

Mainline Improvements

- Providing two GP lanes and one EL in each direction that accommodates transit.
- Remainder of mainline improvements identified in the 3GPL Alternative.

Interchange Improvements

This alternative includes the same interchange improvements identified in the 3GPL Alternative.

Bridge Improvements

This alternative includes the same bridge improvements identified in the 3GPL Alternative.

Bicycle, Pedestrian, Trail, and Transit Improvements

This alternative includes the same bicycle, pedestrian, trail, and transit enhancements identified in the 3GPL Alternative.

6.4 Applicable Guidance

The methodology for the air quality analysis was conducted in accordance with all applicable state regulations and CDOT guidance. It was also informed by federal guidance from EPA and FHWA. The following relevant guidance was applied to the methodology for the analysis, where appropriate, as described in this section, the Work Plan (Appendix A), and the Work Plan amendments (Appendix B).

- Interim Guidance for Project Level Compliance of CRS 43-1-128 (NEPA and Construction) (CDOT 2023)
- Air Quality Project-Level Analysis Guidance (AQ-PLAG), Version 1 (CDOT 2019)
- Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents (FHWA 2023a)
- Frequently Asked Questions (FAQs): Conducting Quantitative Mobile Source Air Toxics (MSAT) Analysis for FHWA NEPA Documents (FHWA 2023b)
- MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity (EPA 2023)
- Guideline for Modeling Carbon Monoxide From Roadway Intersections (EPA 1992)
- Using MOVES3 in Project-Level Carbon Monoxide Analyses (EPA 2021b)¹⁰
- Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in PM_{2.5} and PM₁₀ Nonattainment and Maintenance Areas (EPA 2021c)

¹⁰ Note that, when this analysis was conducted, EPA had not updated the referenced guidance document to reflect use of MOVES4, the latest version of MOVES released in August 2023 with a subsequent “patch” version (MOVES4.0.1) in January 2024; though the guidance applies as for MOVES3 with exception of an update in MOVES4 for Alternate Vehicle Fuel and Technologies (AVFT) fuels input. The MOVES4 technical guidance (EPA 2023) provides further information regarding the AVFT input.

- NEPA Manual, Version 7 (CDOT 2024)¹¹

7.0 Environmental Consequences

This section documents the results of the air quality analysis conducted for the Project. Section 7.1 provides the quantitative emissions inventories for CAPs; Section 7.2 summarizes the quantitative MSAT emissions analysis; Sections 7.3 and 7.4 summarize the comparative CO and PM hot-spot modeling analyses, respectively; and Section 7.5 summarizes the qualitative analysis of construction emissions.

7.1 Quantitative Criteria Pollutant Emission Inventory Analysis Results

The emission inventories for the criteria pollutants were developed to meet state regulatory requirements based on applicable guidance noted in Section 6.4 and methods described in Appendices A, B, and C. The emissions inventories are based on vehicle traffic for the roadway segments included in DRCOG's Focus model¹² and within the air quality study area (see Figure 2 in Section 6.1). This includes all roadway segments affected by the project.¹³

The emissions reported in this section represent motor vehicle emissions resulting from the existing conditions (2023) and the three Project alternatives in the design year (2050). The differences in emissions between the No Action and Project build alternatives in 2050 are solely due to the Project. Variations in the general emission inventory trends for the following criteria pollutants and O₃ precursor pollutants are described in this section:

- PM₁₀
- PM_{2.5}
- CO
- SO₂
- NO₂
- NO_x
- VOC

Because O₃ formation requires a complex chemical reaction of other pollutants to occur, O₃ emissions are not explicitly quantified in the emissions inventories. Rather, the primary precursor pollutants for O₃ formation, NO_x and VOCs, are quantified.

Table 3 below shows estimated daily Vehicle Miles Traveled (VMT) on I-270 and other roadways in the air quality study area shown in Figure 2 for the Project alternatives. As shown in the table, VMT is predicted to increase by 2050 for all Project alternatives, reflecting anticipated regional population and employment growth incorporated into the travel demand

¹¹ Although this air quality analysis was conducted to meet state requirements, guidance for federal analyses informed the approach and methods used.

¹² See <https://www.drcog.org/data-maps-modeling/data-modeling> for more information about Focus.

¹³ Roadways that are not part of the Project build alternatives are included in the analysis based on criteria in Frequently Asked Questions (FAQs): FHWA Recommendations for Conducting Quantitative Mobile Source Air Toxics (MSAT) Analysis for FHWA NEPA Documents (FHWA 2023b).

model that was used to estimate travel activity for the Project.¹⁴ The estimated VMT for each of the Project alternatives is based on traffic volumes and traffic link lengths from the travel demand modeling conducted for the Project. Higher traffic volumes and increased daily VMT were predicted for the Project build alternatives compared to the No Action Alternative due to an increase in corridor capacity associated with the addition of a GP lane (3GPL Alternative) or EL (2GPL+1EL Alternative) in both directions. The table shows that the estimated daily VMT is highest for the 3GPL alternative and lowest for the No Action Alternative. The estimated daily VMT is lower for the 2GPL+1EL Alternative compared to the 3GPL Alternative. Although VMT is projected to increase on I-270 under the Project build alternatives relative to the No Action Alternative, the increases are likely dominated by a redistribution of regional travel demand (i.e., traffic volume shifting to I-270 from other roadways in the region). The changes in VMT and related travel demand model approach is discussed further in Section 8.

Table 3. Daily Vehicle Miles Traveled (VMT)

2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
926,995	1,443,023	1,692,053	1,591,552

Table 4 and Table 5 summarize the modeled criteria pollutant emissions for a typical weekday in representative winter and summer months for the existing conditions year (2023) and the design year (2050). Emissions of most criteria pollutants decrease from existing conditions to the design year for all three Project alternatives, which is attributed to the implementation of more stringent emission standards, improved fuel efficiency, vehicle fleet turnover, and lower emission factors associated with congestion relief. PM_{10} emissions show a slight increase from the existing conditions to the design year because PM_{10} emissions are dominated by the contribution from road dust emissions, which are not affected by vehicle engine standards and the road dust emission factors provided by APCD are independent of speed for moving vehicles.¹⁵ Emissions for the 2GPL+1EL Alternative are estimated to be lower in the design year for all CAPs, compared to the 3GPL Alternative, which is primarily a result of the lower VMT estimated for the 2GPL+1EL Alternative.

Table 4. Criteria Air Pollutant and Ozone Precursor Emissions (in U.S. tons per day) in January (Typical Weekday)

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
PM_{10}	0.327	0.456	0.518	0.488
$PM_{2.5}$	0.033	0.011	0.011	0.010
CO	2.945	0.614	0.679	0.634
SO ₂	0.002	0.001	0.001	0.001
NO ₂	0.070	0.030	0.031	0.028

¹⁴ The travel demand modeling was conducted by CDOT's traffic consultant and is documented under separate cover in the I-270 EIS.

¹⁵ The modeling of road dust emissions associated with on-road vehicles assumes that road dust is only resuspended from the roadway surface for vehicles in motion; road dust emissions from vehicle operation are assumed to be zero for idling vehicles.

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
NO _x	0.906	0.160	0.167	0.153
VOC	0.172	0.061	0.069	0.065

Table 5. Criteria Air Pollutant and Ozone Precursor Emissions (in U.S. tons per day) in July (Typical Weekday)

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
PM ₁₀	0.275	0.374	0.422	0.397
PM _{2.5}	0.033	0.011	0.011	0.010
CO	3.411	0.699	0.777	0.726
SO ₂	0.002	0.001	0.001	0.001
NO ₂	0.061	0.023	0.024	0.022
NO _x	0.790	0.122	0.127	0.117
VOC	0.215	0.066	0.075	0.071

7.2 Quantitative MSAT Analysis

The emission inventories for the nine FHWA priority MSAT pollutants were developed based on applicable guidance in Section 6.4 and methods described in Appendix C. Table 6 and Table 7 summarize the modeled MSAT emissions (in units of pounds per day) for a typical weekday in representative winter and summer months for the existing conditions year (2023) and the design year (2050).

Table 6. MSAT Air Pollutant Emissions (pounds per day) in January (Typical Weekday)

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
1,3-butadiene	0.549	0.000	0.000	0.000
Acetaldehyde	3.274	0.352	0.369	0.340
Acrolein	0.438	0.022	0.023	0.022
Benzene	4.898	0.832	0.939	0.882
DPM	53.093	0.819	0.876	0.800
Ethylbenzene	5.058	2.037	2.317	2.177
Formaldehyde	5.941	0.388	0.414	0.383
Naphthalene	0.699	0.020	0.022	0.021
Polycyclic Organic Matter	0.360	0.009	0.010	0.009

Table 7. MSAT Air Pollutant Emissions (pounds per day) in July (Typical Weekday)

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
1,3-butadiene	0.616	0.000	0.000	0.000
Acetaldehyde	3.317	0.358	0.376	0.346
Acrolein	0.445	0.024	0.025	0.023
Benzene	6.662	1.206	1.367	1.285
DPM	53.093	0.819	0.876	0.800
Ethylbenzene	5.331	2.110	2.403	2.258
Formaldehyde	6.107	0.407	0.436	0.404
Naphthalene	0.717	0.023	0.026	0.024
Polycyclic Organic Matter	0.367	0.010	0.011	0.011

The modeled MSAT emissions decrease between the 2023 existing conditions and the design year (2050) for all three project alternatives. This is consistent with EPA’s national emissions control programs that are projected to reduce annual MSAT emissions by 90 percent from 2010 to 2050 (FHWA 2023a). The much larger decrease in estimated emissions of DPM between 2023 and 2050 compared to the other MSAT is most likely a result of Colorado’s adoption of the Advanced Clean Trucks rule and the corresponding increase of electric vehicles in the medium and heavy-duty truck fleets by 2050. Despite the decrease in MSAT emissions between the 2023 existing conditions and the design year, slightly higher emissions are estimated for some of the pollutants in one or both of the Project build alternatives (3GPL and 2GPL+1EL Alternatives) than in the No Action Alternative in 2050. Lower emissions are predicted for the 2GPL+1EL Alternative than for the 3GPL Alternative. As with the differences in emissions changes for CAPs, differences between MSAT emissions for the No Action and build alternatives and between emissions for the two build alternatives are primarily a result of differences between estimated VMT across the alternatives.

7.3 Comparative CO Hot-Spot Modeling

CO hot-spot modeling is a screening level analysis, designed to evaluate the worst-case scenario using a conservative approach. If modeled concentrations at the most impacted location of a project are less than or equal to the applicable NAAQS, it can be concluded that the project would not cause or contribute to any violations of the CO standard within the project area.

Although this modeling is not required for the Project under state or federal regulations, a comparative quantitative CO hot-spot analysis was conducted to inform the public of potential air quality impacts of the Project alternatives. CO hot-spot modeling was conducted for the No Action and two build alternatives in accordance with CDOT and EPA guidance listed in Section 6.4, and the results were compared across alternatives. The modeling focused on the worst-performing intersection identified in the 2050 horizon-year traffic analysis: Vasquez Boulevard and East 56th Avenue. This location exhibited the highest traffic volumes and delays in both build alternatives. Using EPA’s CAL3QHC model (version 2.0), CO concentrations were estimated at receptor locations surrounding the intersection for AM peak

and PM peak hours. The modeling incorporated conservative assumptions in accordance with EPA CO hot-spot guidance, including worst-case meteorological conditions that limit dispersion (e.g., low wind speed of 1 m/s and neutral vertical mixing), CO emission rates from vehicles at the intersection that were modeled using MOVES4 emission factors based on the 2023 fleet mix data, and the 2050 peak traffic volumes. APCD provided a 1-hour CO background concentration of 4.976 ppm, which was added to the model-estimated concentration. The total concentration was compared against the NAAQS thresholds. Additional details about the analysis methods are provided in Appendix A and Appendix D.

The results of the analysis are summarized in Table 8 and Table 9. Maximum predicted 1-hour CO concentrations including the background contribution, ranged from 5.78 ppm to 6.68 ppm across the Project alternatives and AM and PM peak hours. Corresponding 8-hour concentrations, derived by multiplying the maximum 1-hour CO concentrations by the regionally specific persistence factor of 0.649 (provided by APCD), ranged from 3.75 ppm to 4.33 ppm. These maximum concentrations were all well below the applicable NAAQS limits of 35 ppm (1-hour) and 9 ppm (8-hour) under the worst-case traffic and meteorological conditions that were analyzed. For the AM peak hour, the maximum 1-hour and 8-hour CO concentrations were lowest in the No Action Alternative, and lower in the 2GPL+1EL Alternative than in the 3GPL Alternative. For the PM peak hour, the maximum 1-hour and 8-hour CO concentrations were the same in the No Action and 3GPL Alternatives, and lowest in the 2GPL+1EL Alternative.

Table 8. Maximum Modeled + Background 1-Hour CO Concentration (ppm) for the Worst-Performing Intersection in 2050 (1-Hr CO NAAQS = 35 ppm)

Alternative	AM Peak Hour	PM Peak Hour
No Action	5.78	5.98
3GPL	6.68	5.98
2GPL+1EL	6.38	5.88

Table 9. Maximum Modeled + Background 8-Hour CO Concentration (ppm) for the Worst-Performing Intersection in 2050 (8-Hr CO NAAQS = 9 ppm)

Alternative	AM Peak Hour	PM Peak Hour
No Action	3.75	3.88
3GPL	4.33	3.88
2GPL+1EL	4.14	3.81

These results primarily reflect a combination of the following inputs to the CAL3QHC model: the volume of traffic that cruises through the intersection and the speeds at which they travel, and the red signal durations at the intersection. Differences in the model-predicted CO concentrations across the Project alternatives and the two peak hours are directly related to differences in the traffic volumes, speeds that are dependent on the level of congestion, and the signalization inputs. During the AM peak hour, the differences in modeled CO concentrations are primarily a result of greater modeled traffic volumes traveling through the intersection at lower speeds on average in the two Build Alternatives compared to the No Action Alternative. In the PM peak hour, cruising traffic volumes in the model are lower in the

two Build Alternatives compared to the No Action Alternative and lowest in the 2GPL+1EL Alternative on average. However, lower modeled speeds (i.e., more congestion) on average in the Build Alternatives during the PM peak hour offsets the effect of lower traffic volume on emissions. This results in similar emissions and predicted CO concentrations for the 3GPL and No Action Alternatives in the PM peak hour, but the average modeled volume of cruising traffic is lowest for the 2GPL+1EL Alternative. The model inputs also indicate less delay, on average, during the PM peak hour for the 2GPL+1EL Alternative.

7.4 Comparative PM Hot-Spot Modeling

7.4.1 Overview of the Analysis

Dispersion modeling of motor vehicle PM_{10} and $PM_{2.5}$ emissions resulting from the Project was conducted to compare potential air quality impacts of the Project alternatives in the design year (2050). Although this modeling is not required for the Project under state or federal regulations, CDOT included it in the analysis to help alleviate community and stakeholder concerns about air quality in the I-270 area, as described in the Introduction (Section 1). The guidance applicable to quantitative PM hot-spot analyses listed in Section 6.4 was used to inform the modeling methodology. The methodology is discussed in the Work Plan (Appendix A) and Work Plan amendments (Appendix B). Additional details of the methods and development of model inputs are provided in Appendix E. Methods for using MOVES to develop the emission rate inputs for the PM dispersion modeling are described in Appendices A and C.

A total of nine PM dispersion modeling simulations using AERMOD were conducted for this comparative hot-spot analysis: 24-hour average PM_{10} , 24-hour average $PM_{2.5}$, and annual average $PM_{2.5}$ were modeled for each of the three Project alternatives (No Action, 3GPL, and 2GPL+1EL). Following EPA's PM hot-spot guidance, maximum design concentrations (DCs) for each Project alternative and PM averaging time were calculated as the sum of the modeled contribution from the Project alternative and the representative background concentration. The modeled contribution is the maximum ranked-value concentration, with the rank dependent upon the modeled pollutant/averaging time and statistical form of the corresponding NAAQS (see Appendix E for additional details).

The background concentrations used in this analysis were derived by APCD using data from EPA's AQS and methods consistent with the forms of the NAAQS (see Table 1 in Section 2.1). The Work Plan described representative background concentrations that APCD had derived in June 2023 using data from the Commerce City monitoring site for the years 2018, 2019, and 2022, noting that updated background concentrations would be used for the analysis if they became available. On July 23, 2024, APCD provided updated representative background concentrations that reflected the most recent complete set of monitoring data, including measurements from the year 2023. To derive the representative background concentrations provided for this analysis, APCD used measurements at the Commerce City monitoring site (AQS site ID 08-001-0010)¹⁶ from 2019, 2022, and 2023, and excluded days that were impacted by wildfire smoke. Data from 2020 and 2021 were not used in their analysis because measurements were not collected from November 2, 2020 - mid-March 2021 due to roofing

¹⁶ Note that the AQS site ID for this monitor was changed from that shown in the Work Plan (08 001-0008) when it was relocated from 4201 72nd Avenue to 7275 Birch St.

construction at the monitoring site. The resulting background concentrations that APCD provided for the PM modeling analysis are listed with the corresponding NAAQS in Table 10.

Table 10. Representative Background PM Concentrations and Corresponding NAAQS

Pollutant/Averaging Time	Background Concentration ($\mu\text{g}/\text{m}^3$)	NAAQS ($\mu\text{g}/\text{m}^3$)
PM ₁₀ (24-hour average)	92	150
PM _{2.5} (24-hour average)	20	35
PM _{2.5} (Annual average)	8.1	9.0

The annual average PM_{2.5} background concentration provided by APCD is notable because it is only 10% lower than the NAAQS. Although the annual PM_{2.5} background concentration provided by APCD may not be considered unusual given that concentrations at many locations in the U.S. have recently been near or above $8.0\mu\text{g}/\text{m}^3$,¹⁷ the magnitude is notable because CDOT identified similar or lower concentrations at near-road sensors in the I-270 corridor, which include the regional background concentration and the roadway source contribution. Table 11 presents annual PM_{2.5} concentrations based on an analysis by CDOT¹⁸ of data collected at three near-road sensors (see Figure 7) that are part of a CDOT air quality research project.¹⁹

Table 11. Annual Average PM_{2.5} Concentrations ($\mu\text{g}/\text{m}^3$) based on CDOT I-270 Research Project Data by Sensor Site

Year	York St E-6S	South Platte	Vasquez Blvd-13S
2023	8.1 ¹	N/A	6.9
2024	N/A	7.5 ²	5.8 ³

¹ Data completeness was 69% in quarter 2.

² Data completeness was 57% in quarter 4.

³ Data completeness was 57% in quarter 4.

Because the near-road concentrations include background and roadway source contributions, the background concentration at a representative regional monitor could reasonably be expected to be less than the near-road concentrations. At the Commerce City monitoring site, which APCD used to determine the representative background concentrations, the annual PM_{2.5} concentrations for calendar years 2023 and 2024 (see Table 2 in Section 4.2) are greater than the corresponding near-road concentrations in Table 11 at two of the three near-road

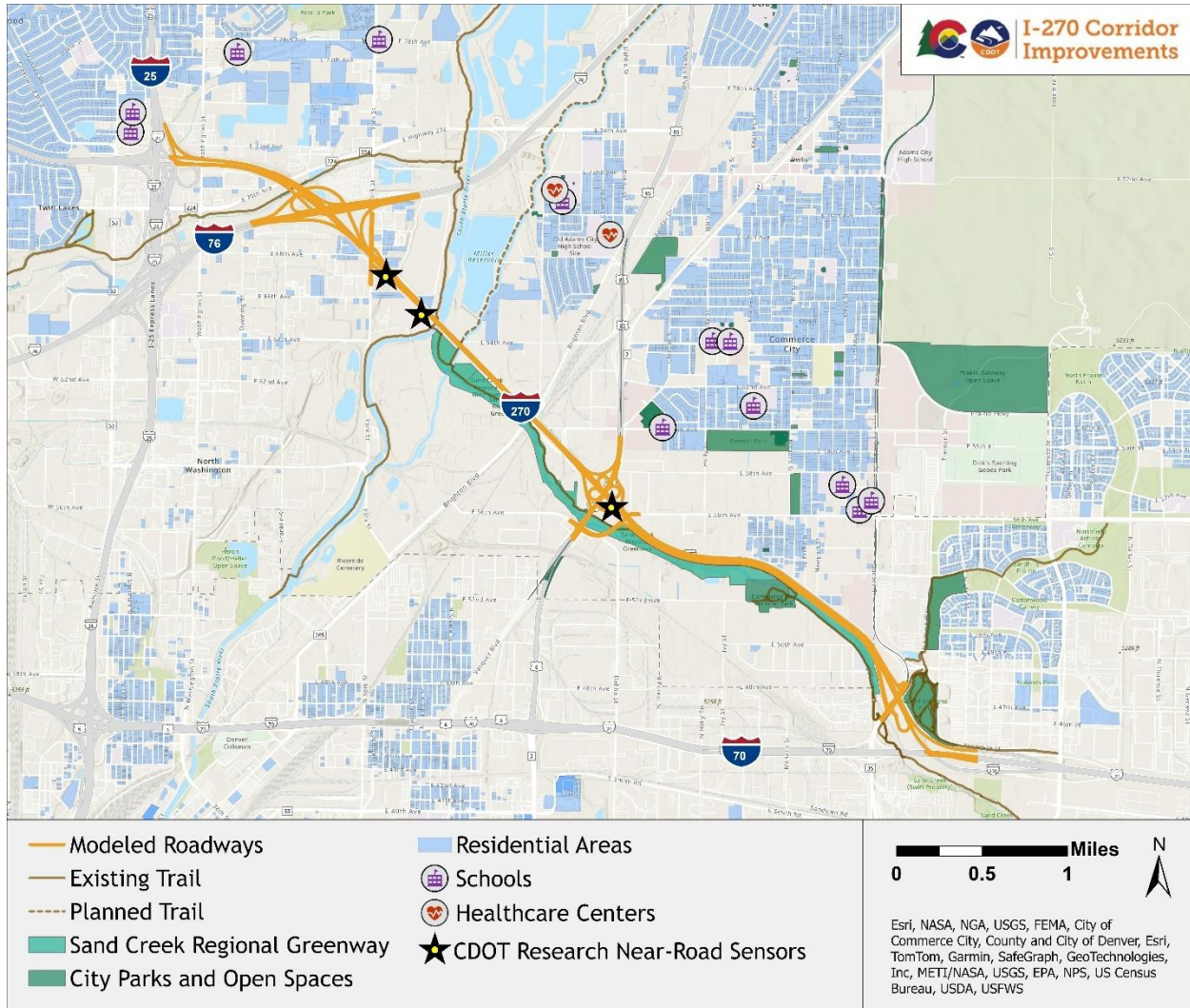
¹⁷ Annual PM_{2.5} concentrations were above $8\mu\text{g}/\text{m}^3$ in many areas of the U.S. in the last three years: the 2024 annual PM_{2.5} DVs published in EPA's 2024 Design Value Report for PM_{2.5} were above $8\mu\text{g}/\text{m}^3$ in one or more counties in 35 states and in the District of Columbia (data available at https://www.epa.gov/system/files/documents/2025-06/pm25_designvalues_2022_2024_final_05_28_25.xlsx).

¹⁸ CDOT determined the annual average PM_{2.5} concentrations in Table 11 for years which had complete or near complete data sets; note that a minimum of 75% data completeness in each calendar quarter based on a monitor's operating schedule and monitoring frequency is valid for regulatory purposes.

¹⁹ CDOT has been operating these non-regulatory sensors for the purposes of the research project since 2022. The sensors were calibrated by the manufacturer alongside CDPHE-operated PM_{2.5} monitors in the Denver Metro area.

sensors along I-270. This might suggest that the annual $PM_{2.5}$ background concentration provided by APCD for the PM hot-spot modeling analysis may not be representative for the study area in the analysis²⁰ and that its use in this analysis might result in overestimated annual $PM_{2.5}$ DCs. The DCs in some locations in the study area might also be overestimated due to conservative assumptions in the hot-spot modeling, as discussed in the next section.

Figure 7. Locations of CDOT Research-Project Near-Road Sensors in the I-270 Corridor



7.4.2 Summary and Discussion of Modeling Results

After completion of each AERMOD simulation for a Project alternative and pollutant/averaging time, DCs were calculated for each model receptor as the sum of the model-estimated and background concentrations. The maximum DCs (in units of $\mu g/m^3$) across all model receptors for each of the three Project alternatives and pollutant/averaging times

²⁰ The use of different monitoring methods for the near-road sensors and the Commerce City regulatory monitoring site increases the uncertainty of direct comparisons between the background and near-road $PM_{2.5}$ concentrations, although the same monitoring method is used for all three near-road sensors.

are summarized in Tables 12 through 14. The modeled and background contributions to each maximum DC are also listed in the tables.²¹ These results indicate that the 2GPL+1EL Project Alternative has the lowest impact on air quality in the study area based on the modeled contribution to the DCs for 24-hr PM_{10} , 24-hr $PM_{2.5}$ and annual $PM_{2.5}$. In fact, the modeled contributions to calculated DCs in the 2GPL+1EL Alternative are less than those in the 3GPL Alternative at ~60% to 80% of the modeled receptors, depending on the pollutant/averaging time. The DCs exhibit the same trend as the modeled contributions, except that the 24-hr PM_{10} DC is the same in the 3GPL and 2GPL+1EL Alternatives. This is because the combined modeled and background contributions are rounded to the nearest $10 \mu\text{g}/\text{m}^3$ for 24 hr PM_{10} DCs.²² The DC in the 3GPL Alternative is lower than in the No Action Alternative for 24-hr PM_{10} and 24-hr $PM_{2.5}$, but is slightly higher for annual $PM_{2.5}$. The maximum calculated DCs summarized in Tables 12-14 occur at receptors located within about 5-30 meters of the modeled roadway emissions sources. As the figures presented in the next section (Section 7.4.3) show for each alternative and pollutant/averaging time, the DCs in the majority of the modeling domain are substantially lower than the maximum DC.

Table 12. Maximum 24-Hr Average PM_{10} Design Concentrations (NAAQS = $150 \mu\text{g}/\text{m}^3$)¹

Alternative	Modeled Contribution	Background Contribution	Modeled + Background Contributions	Design Concentration
No Action	71.70811	92	163.70811	160
3GPL	55.62439	92	147.62439	150
2GPL+1EL	53.71573	92	145.71573	150

¹ All values are in units of $\mu\text{g}/\text{m}^3$.

Table 13. Maximum 24-Hr Average $PM_{2.5}$ Design Concentrations (NAAQS = $35 \mu\text{g}/\text{m}^3$)¹

Alternative	Modeled Contribution	Background Contribution	Modeled + Background Contributions	Design Concentration
No Action	14.77794	20	34.77794	35
3GPL	12.80289	20	32.80289	33
2GPL+1EL	10.88717	20	30.88717	31

¹ All values are in units of $\mu\text{g}/\text{m}^3$.

²¹ For hot-spot analyses, rounding to the appropriate digit, depending on the pollutant/averaging time, only occurs in the final step of calculating the DC. Therefore, all decimal places in model-estimated concentrations produced by AERMOD were retained in the intermediate summation of the model-estimated and background concentrations. The rounding procedures are described in Appendix E.

²² The 24-hr PM_{10} DCs tend to be equal in the two build alternatives because of the large rounding unit for that pollutant/averaging time.

Table 14. Maximum Annual Average PM_{2.5} Design Concentrations (NAAQS = 9.0 µg/m³)^{1,2}

Alternative	Modeled Contribution	Background Contribution	Modeled + Background Contributions	Design Concentration
No Action	3.19678	8.1	11.29678	11.3
3GPL	3.50267	8.1	11.60267	11.6
2GPL+1EL	2.98847	8.1	11.08847	11.1

¹ Annual PM_{2.5} concentrations correspond to the network of receptors representing residential areas, schools, hospitals, and churches (childcare facilities were classified as schools based on their educational focus, and no eldercare facilities were identified in referenced land use datasets). As described in Appendices B and E the annual PM_{2.5} receptor network is different than the one defined for the PM₁₀ and PM_{2.5} 24-hour averaging times.

² All values are in units of µg/m³.

Comparing the calculated DCs with the respective NAAQS and across the Project Alternatives:

- The maximum 24-hr PM₁₀ DC for the No Action Alternative is above the NAAQS, while that for the 3GPL and 2GPL+1EL Alternatives is equal to the NAAQS.²³
- The maximum 24-hr PM_{2.5} DCs for the three Project Alternatives are at (for the No Action Alternative) or below (for the two Build Alternatives) the corresponding NAAQS.
- The maximum annual average PM_{2.5} DCs for all three Alternatives are above the corresponding NAAQS, which is likely driven by the outsized contribution of the annual PM_{2.5} background concentration, which accounts for 70% to 76% of the total (modeled plus background) contribution before rounding to the DC. For comparison, the 24-hr PM₁₀ and 24-hr PM_{2.5} background concentrations account for 56% to 65% of the total contribution before rounding to the DC.
- The 2GPL+1EL Alternative results in the lowest maximum DC for all modeled pollutant/averaging times (24-hr PM₁₀, 24-hr PM_{2.5}, and annual PM_{2.5}).

It is important to acknowledge that annual PM_{2.5} concentrations in the Project area and surrounding region have generally been declining as a result of pollution control measures. Figure 8 shows the EPA-published annual PM_{2.5} DV history (site trends)²⁴ for the last 10 years at monitors in the Project area and surrounding region, including the Commerce City, I-25 Globeville, I-25 Denver, Colorado Air Monitoring Program (CAMP), and La Casa monitors, and illustrates this decline in concentrations. The monitor locations and most recent annual PM_{2.5} DVs are displayed in Figure 9 along with the locations and most recent annual PM_{2.5} concentrations at the CDOT research near-road sensors discussed in **Section 7.4.1**. The trend of declining annual PM_{2.5} DVs is expected to continue into the future, and the maximum annual PM_{2.5} DCs summarized in Table 14 might have been less than the 2024 NAAQS (9.0 µg/m³) if the background concentration represented conditions in 2050 (the modeled design

²³ Although PM₁₀ emissions are predicted to be lowest in 2050 for the No Action Alternative compared to the Project Build Alternatives because they are dominated by PM₁₀ road dust and the dependence on VMT (see Section 7.1), the lower modeled PM₁₀ concentrations in the Project Build Alternatives are likely due to more queueing of traffic at intersections in the Build Alternatives during time periods with high traffic volumes. Idling vehicles are not sources of road dust emissions, and the highest PM₁₀ concentrations occur at receptors closest to modeled intersections.

²⁴ Data were obtained from Table 6a in EPA's 2024 Design Value Report for PM_{2.5}:
https://www.epa.gov/system/files/documents/2025-06/pm25_designvalues_2022_2024_final_05_28_25.xlsx.

year) rather than conditions in the recent years (2019, 2022, and 2023). Although a future-year background concentration can be used in PM hot-spot analyses (EPA 2021c), this analysis relied, conservatively, on the background concentrations based on measurements collected in recent years at the Commerce City regulatory monitoring site.

Figure 8. Annual PM_{2.5} Design Value Trends in the Project Area and Surrounding Region

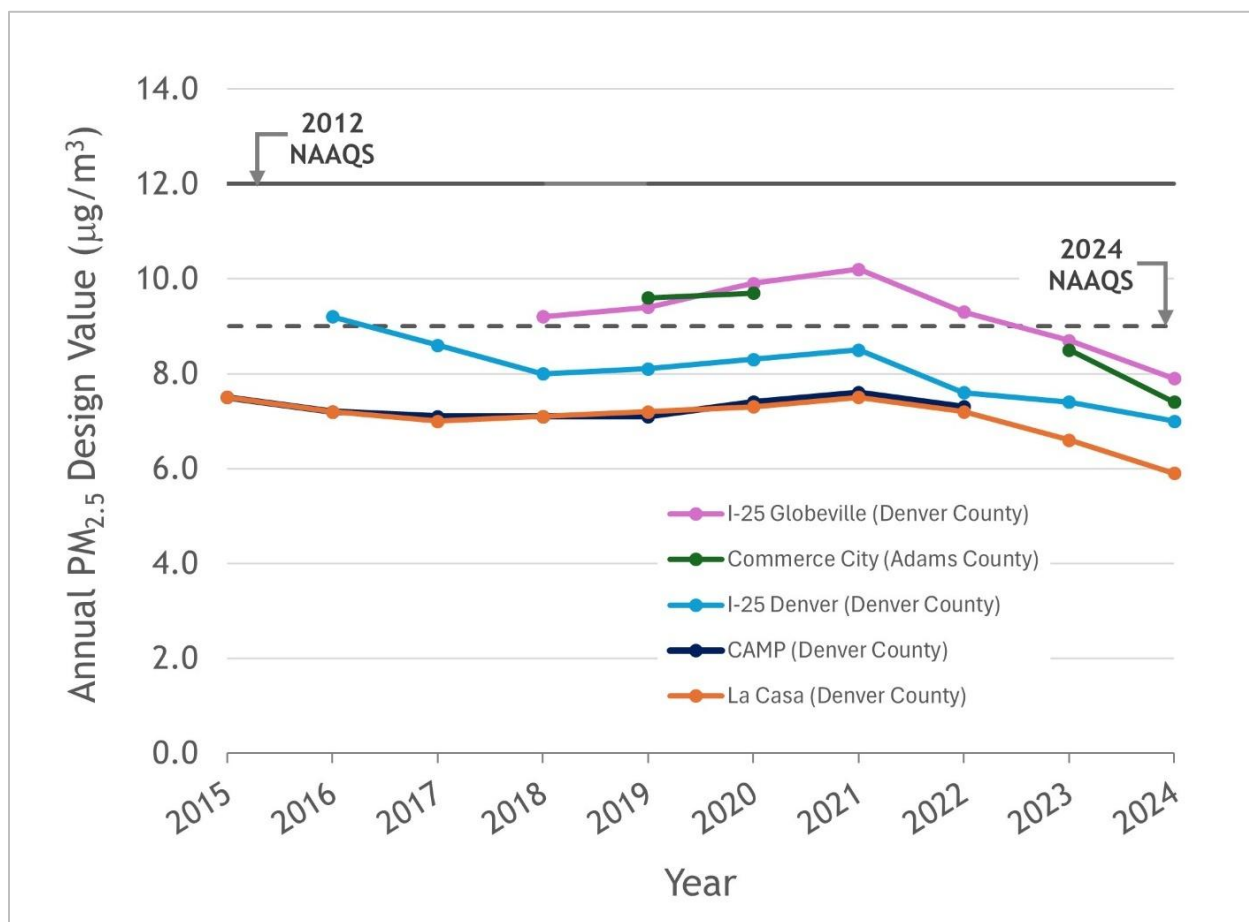
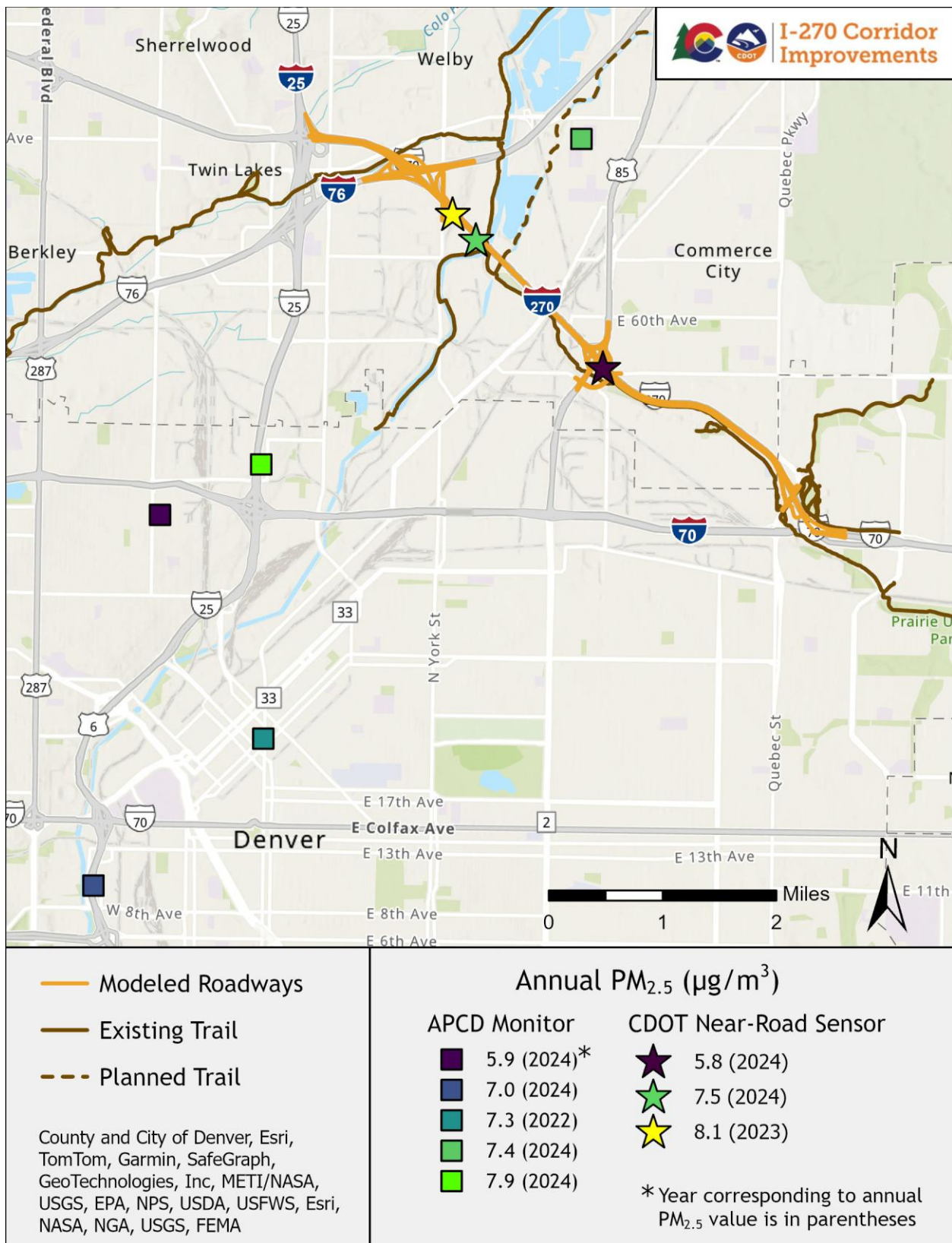


Figure 9. Annual PM_{2.5} Design Values and Concentrations at APCD Monitors and Near-Road Sensors



Tables 15 through 17 list the maximum model-estimated concentrations and corresponding DCs that include the background concentration for each pollutant/averaging time at the sensitive receptors identified from public input. Some of these receptors represent an individual site with relatively small area (e.g., the Suncor Boys and Girls Club and Sanville Preschool) and some represent a larger area (e.g., Welby and Adams Heights residential areas). Many are located beyond 500 meters from the Project roadways where the model receptor network for the analysis would not otherwise extend.²⁵ The number of model receptors defined to represent these sensitive locations depended on their size. For example, a single model receptor was sufficient to capture the maximum DC at the location of the Suncor Boys and Girls Club, while approximately 40 model receptors were needed for the Welby residential area. As a result of modeling the larger sensitive locations with multiple receptors, the maximum DCs in some of those areas occurred at different model receptors across the three Project alternatives. For example, among the multiple model receptors representing the Welby area, the maximum 24-hr average PM_{10} DCs occurred at different, nearby receptors across the three Project alternatives. Therefore, some of the DCs in Tables 15 through 17 for locations represented by multiple model receptors are not suitable for direct comparison across the Project alternatives. However, the DCs listed in the tables represent the overall maximum value in each of those locations for each Project alternative. These results show that the maximum modeled 24-hr PM_{10} and 24-hr $PM_{2.5}$ concentrations contribute much less to the DCs than the background concentration and the DCs are below the NAAQS at all these sensitive receptors. The maximum modeled annual $PM_{2.5}$ concentrations also contribute much less to the DCs than the background concentration, and the DCs are below the NAAQS at all the sensitive receptor locations except those closest to the roadway emissions sources at Northfield Pond Park and Wetland Park. Overall, these results demonstrate that the model predicts minimal contributions to ambient PM concentrations from the Project relative to the background concentrations.

²⁵ EPA guidance recommends placing receptors out to about 100 meters from modeled roadways, and little change in model-estimated concentrations with distance beyond 500 meters would be expected.

Table 15. Maximum 24-Hour Average PM₁₀ Modeled and Design Concentrations (µg/m³) at Sensitive Receptors Identified from Public Input (NAAQS = 150 µg/m³)

Location	No Action Model ¹	No Action DC	3GPL Model	3GPL DC	2GPL+1EL Model	2GPL+1EL DC
Adams County School District 14	3	90	3	100	3	100
Adams Heights Neighborhood	3	100	3	100	3	100
Alsup Elementary School	1	90	2	90	2	90
Assumption Catholic School	2	90	2	90	2	90
C4 Campus	1	90	2	90	1	90
Central Elementary School	1	90	1	90	1	90
Kearney Middle School	1	90	2	90	2	90
Kids First Health Care	1	90	2	90	2	90
Leyden Park	9	100	11	100	10	100
Monaco Park	3	100	3	100	3	100
Northfield Pond Park	32	120	27	120	30	120
Pioneer Park & Paradise Island Pool	2	90	2	90	2	90
Rose Hill Elementary School	2	90	2	90	2	90
Sanville Preschool	1	90	1	90	1	90
Suncor Boys & Girls Club	2	90	2	90	2	90
Sunshine Head Start	2	90	2	90	2	90
Veterans Memorial Park	3	100	4	100	4	100
Victory Preparatory Academy	2	90	2	90	2	90
Welby Community School	2	90	3	100	3	100
Welby Area Residents	5	100	5	100	5	100
Wetland Park	16	110	19	110	18	110
14 Stars Early Learning Center	2	90	3	90	3	90

¹ “Model” indicates the AERMOD-modeled contribution to the maximum DC at the sensitive receptors listed in the table. The values account for rounding that is reflected in the DCs.

Table 16. Maximum 24-Hour Average PM_{2.5} Modeled and Design Concentrations (µg/m³) at Sensitive Receptors Identified from Public Input (NAAQS = 35 µg/m³)

Location	No Action Model ¹	No Action DC	3GPL Model	3GPL DC	2GPL+1EL Model	2GPL+1EL DC
Adams County School District 14	1	21	1	21	1	21
Adams Heights Neighborhood	1	21	1	21	1	21
Alsup Elementary School	0	20	0	20	0	20
Assumption Catholic School	1	21	1	21	1	21
C4 Campus	0	20	0	20	0	20
Central Elementary School	0	20	0	20	0	20
Kearney Middle School	0	20	0	20	0	20
Kids First Health Care	0	20	0	20	0	20
Leyden Park	2	22	3	23	2	22
Monaco Park	1	21	1	21	1	21
Northfield Pond Park	6	26	6	26	7	27
Pioneer Park & Paradise Island Pool	1	21	1	21	1	21
Rose Hill Elementary School	1	21	1	21	1	21
Sanville Preschool	0	20	0	20	0	20
Suncor Boys & Girls Club	0	20	1	21	1	21
Sunshine Head Start	0	20	1	21	1	21
Veterans Memorial Park	1	21	1	21	1	21
Victory Preparatory Academy	0	20	1	21	1	21
Welby Community School	1	21	1	21	1	21
Welby Area Residents	1	21	1	21	1	21
Wetland Park	3	23	4	24	4	24
14 Stars Early Learning Center	1	21	1	21	1	21

¹ “Model” indicates the AERMOD-modeled contribution to the maximum DC at the sensitive receptors listed in the table. The values account for rounding that is reflected in the DCs.

Table 17. Maximum Annual Average PM_{2.5} Modeled and Design Concentrations (µg/m³) at Sensitive Receptors Identified from Public Input (NAAQS = 9.0 µg/m³)

Location	No Action Model ¹	No Action DC	3GPL Model	3GPL DC	2GPL+1EL Model	2GPL+1EL DC
Adams County School District 14	0.3	8.4	0.3	8.4	0.3	8.4
Adams Heights Neighborhood	0.2	8.3	0.3	8.4	0.3	8.4
Alsup Elementary School	0.1	8.2	0.2	8.3	0.1	8.2
Assumption Catholic School	0.1	8.2	0.2	8.3	0.2	8.3
C4 Campus	0.1	8.2	0.2	8.3	0.1	8.2
Central Elementary School	0.1	8.2	0.1	8.2	0.1	8.2
Kearney Middle School	0.1	8.2	0.2	8.3	0.2	8.3
Kids First Health Care	0.1	8.2	0.2	8.3	0.1	8.2
Leyden Park	0.8	8.9	1.0	9.1	1.0	9.1
Monaco Park	0.2	8.3	0.3	8.4	0.3	8.4
Northfield Pond Park	2.9	11.0	2.6	10.7	3.0	11.1
Pioneer Park & Paradise Island Pool	0.2	8.3	0.2	8.3	0.2	8.3
Rose Hill Elementary School	0.2	8.3	0.2	8.3	0.2	8.3
Sanville Preschool	0.1	8.2	0.1	8.2	0.1	8.2
Suncor Boys & Girls Club	0.2	8.3	0.2	8.3	0.2	8.3
Sunshine Head Start	0.2	8.3	0.2	8.3	0.2	8.3
Veterans Memorial Park	0.3	8.4	0.3	8.4	0.3	8.4
Victory Preparatory Academy	0.2	8.3	0.2	8.3	0.2	8.3
Welby Community School	0.2	8.3	0.2	8.3	0.2	8.3
Welby Area Residents	0.4	8.5	0.4	8.5	0.4	8.5
Wetland Park	1.4	9.5	1.6	9.7	1.6	9.7
14 Stars Early Learning Center	0.2	8.3	0.2	8.3	0.2	8.3

¹ “Model” indicates the AERMOD-modeled contribution to the maximum DC at the sensitive receptors listed in the table. The values account for rounding that is reflected in the DCs.

When considering the results of this PM hot-spot modeling analysis, it is important to recognize that the contribution of on-road emissions sources to the calculated DCs are estimates based on AERMOD dispersion modeling, and all models have associated uncertainties and limitations. Several published studies have evaluated the performance of AERMOD by comparing model-estimates to near-road PM concentration measurements at specific locations within the modeling domain (Chen et al. 2009; Heist et al. 2013; Claggett 2014; Craig et al. 2020; NASEM 2023). Some of these studies comparatively evaluate dispersion model performance using different model source types in AERMOD and different dispersion models. The performance of AERMOD generally varies across these studies due to different real-world settings for the comparison of measurements and model-estimates of concentrations. A recent National Cooperative Highway Research Program (NCHRP) study (NASEM 2023) included an intercomparison of dispersion model performance for near-road applications and uncertainties in the modeling chain (i.e., traffic, emissions, dispersion, and

determining representative background concentrations). The authors of the study found that AERMOD with two different source-type configurations (area and volume source)²⁶ performed better than other models for 24-hr $PM_{2.5}$ DVs²⁷ and AERMOD with a volume source-type configuration performed best for the annual $PM_{2.5}$ DVs in terms of the absolute difference between model- and measurement-based values. However, the AERMOD volume source model overestimated the annual $PM_{2.5}$ DV, while the AERMOD area source model underestimated the DV. In that study, the authors determined that the dispersion model was not the primary source of uncertainty in modeling results. Rather, they identified traffic emissions inputs to the model and background concentrations as the leading contributors to uncertainty. Key dispersion model uncertainties that were acknowledged include initial vertical dispersion and corresponding emissions release height inputs,²⁸ particularly for heavy-duty trucks, and AERMOD sensitivity to surface roughness length related to land use within the modeled area. It is widely known that AERMOD is highly sensitive to surface roughness as well as wind speed and direction.

For the I-270 PM hot-spot modeling, the best available data were used as input to AERMOD. The emissions inputs were based on MOVES4 modeling with county-specific data provided by CDOT and APCD, and APCD provided the best available meteorological data representative of the Project area. Refined model inputs were used to better characterize elevated roadways and receptors within limited extents at two locations: the I-270/Vasquez and I-270/Quebec interchanges. Source-receptor elevation differences were not characterized throughout the modeling domain because the flat terrain AERMOD option was used, as recommended in EPA's guidance (EPA 2021c),²⁹ and characterizing those differences without use of AERMOD's complex terrain option is greatly restrained by variation of elevation differences along the I-270 corridor. Accounting for source-receptor elevation differences throughout the corridor would likely have resulted in lower model-estimated concentrations at a large number of receptors, especially in proximity to the elevated and depressed stretches of I-270, as well as I-76 near York St.

7.4.3 Visualization of Modeling Results

This section concludes with the presentation of the PM hot-spot modeling results illustrated in a series of figures that show detailed plots of the results for each pollutant/averaging time and Project alternative.³⁰ In each of these figures, the results are presented as the sum of the

²⁶ AERMOD uses different inputs and computations for different types of emissions sources. Area or volume source types in AERMOD are recommended by EPA for use in transportation conformity PM hot-spot analyses (EPA 2021c). As described in the Work Plan for the air quality analysis, the AERMOD volume source type was used in the PM hot-spot modeling for the I-270 Project.

²⁷ In a PM hot-spot analysis, selection of the model-estimated concentration used in calculating the DC is based on the statistical form of the design value.

²⁸ The initial vertical dispersion and release height represent the vertical spread of emissions and the center of that spread above the roadway, respectively, before the emissions disperse.

²⁹ EPA recommends using the flat terrain option to avoid underestimating concentrations in certain circumstances that are likely to occur with modeled on-road vehicle emission sources.

³⁰ Note that the upper limit of the highest concentration bin in each plot is determined by the maximum concentration, which differs across the Alternatives. Also, an additional contour bin is included in Figure 10, compared to the plots for the 3GPL and 2GPL+1EL Alternatives in Figures 11 and 12, to illustrate that the maximum 24-hr PM_{10} DC for the No Action Alternative exceeds the NAAQS.

model-estimated concentration (Project contribution to the DC) and the corresponding background concentration before rounding to the DC.³¹ These figures also show the location of the maximum calculated DCs listed in Tables 12 through 14.³² All the figures show that the highest concentrations occur close to the roadways and concentrations decrease substantially with distance from the roadways.

The analysis results for 24-hr average PM_{10} and 24-hr average $PM_{2.5}$ are displayed in Figures 10 through 15 as contour plots, while those for annual average $PM_{2.5}$ are displayed in Figures 16 through 18 as individual points because an alternative receptor network was used for modeling annual $PM_{2.5}$ concentrations (see Appendix E) and interpolating concentrations across large spatial gaps between model receptors in that network would produce unrealistic contours and inaccurate results. Receptors in the alternative network used for modeling annual $PM_{2.5}$ concentrations are not spatially contiguous because the network focuses on locations where long-term exposure is expected (e.g., residential areas, schools, hospitals, and churches). This unique receptor network was developed to appropriately represent area-wide air quality, which corresponds with the definition of annual $PM_{2.5}$ health standards and location of monitoring sites that are eligible for comparison to the annual $PM_{2.5}$ NAAQS (EPA 2021c).

Figures 10 through 12 display the 24-hour average PM_{10} results for each alternative. Figure 10 shows a contour plot of the 24-hour average PM_{10} results for the No Action Alternative and an inset display of the Vasquez Boulevard and East 56th Avenue intersection where the maximum model-estimated plus background concentration is located at a receptor near the northeast corner of the intersection. Figure 11 shows a contour plot of the 24-hour average PM_{10} results for the 3GPL Alternative and an inset display where the maximum concentration is located at a receptor between the westbound and eastbound lanes of I-270 along the South Platte River Trail, where the trail passes beneath the freeway. Figure 12 shows a contour plot of the 24-hour average PM_{10} DCs for the 2GPL+1EL Alternative and an inset display of the Vasquez Boulevard and East 56th Avenue intersection where the maximum concentration is located near the northwest corner of the intersection.

Figures 13 through 15 display the 24-hour average $PM_{2.5}$ results for each alternative. Figure 13 illustrates a contour plot of the 24-hour average $PM_{2.5}$ results for the No Action Alternative and an inset display of the Vasquez Boulevard and East 56th Avenue intersection where the maximum concentration is at the northeast corner of the intersection. Figure 14 shows a contour plot of the 24-hour average $PM_{2.5}$ results for the 3GPL Alternative and an inset display where the maximum concentration is located at a receptor between the westbound and eastbound lanes of I-270 along the South Platte River Trail, where the trail passes beneath the freeway. Figure 15 shows a contour plot of the 24-hour average $PM_{2.5}$ results for the 2GPL+1EL Alternative and an inset display of the Vasquez Boulevard and East 56th Avenue

³¹ The values are plotted before rounding to the DC to provide greater resolution in the visual display of the model results, particularly because the 24-hr PM_{10} values are rounded to the nearest $10 \mu\text{g}/\text{m}^3$.

³² Illustrations of the model volume sources used to represent the roadway emission sources are visible in the insets that show the locations of maximum DCs in Figures 10-18; they appear as white (Figures 10 through 15) or black (Figures 16 through 18) filled circles, each having a diameter equal to the width of an AERMOD volume source.

intersection where the maximum concentration is located near the northwest corner of the intersection.

Figures 16 through 18 display the annual average $PM_{2.5}$ results for each alternative. Figure 16 presents the annual average $PM_{2.5}$ results for the No Action Alternative and an inset display of York Street between East 68th Place and East 69th Place where the maximum concentration is located at a receptor adjacent to York Street. Figure 17 shows the annual average $PM_{2.5}$ results for the 3GPL Alternative and an inset display of the same area shown in Figure 16 where the maximum concentration is also located at the same receptor adjacent to York Street. Figure 18 shows the annual average $PM_{2.5}$ results for the 2GPL+1EL Alternative and an inset display of the southeast end of Northfield Pond Park near The Shops At Northfield where the maximum concentration is located at a receptor between East 45th Avenue and I-270 adjacent to the park.

Figure 10. Contour Plot of 24-hour Average PM₁₀ DCs (Before Rounding) and the Location of the Maximum DC (at the Vasquez Boulevard/East 56th Ave Intersection) in the No Action Alternative

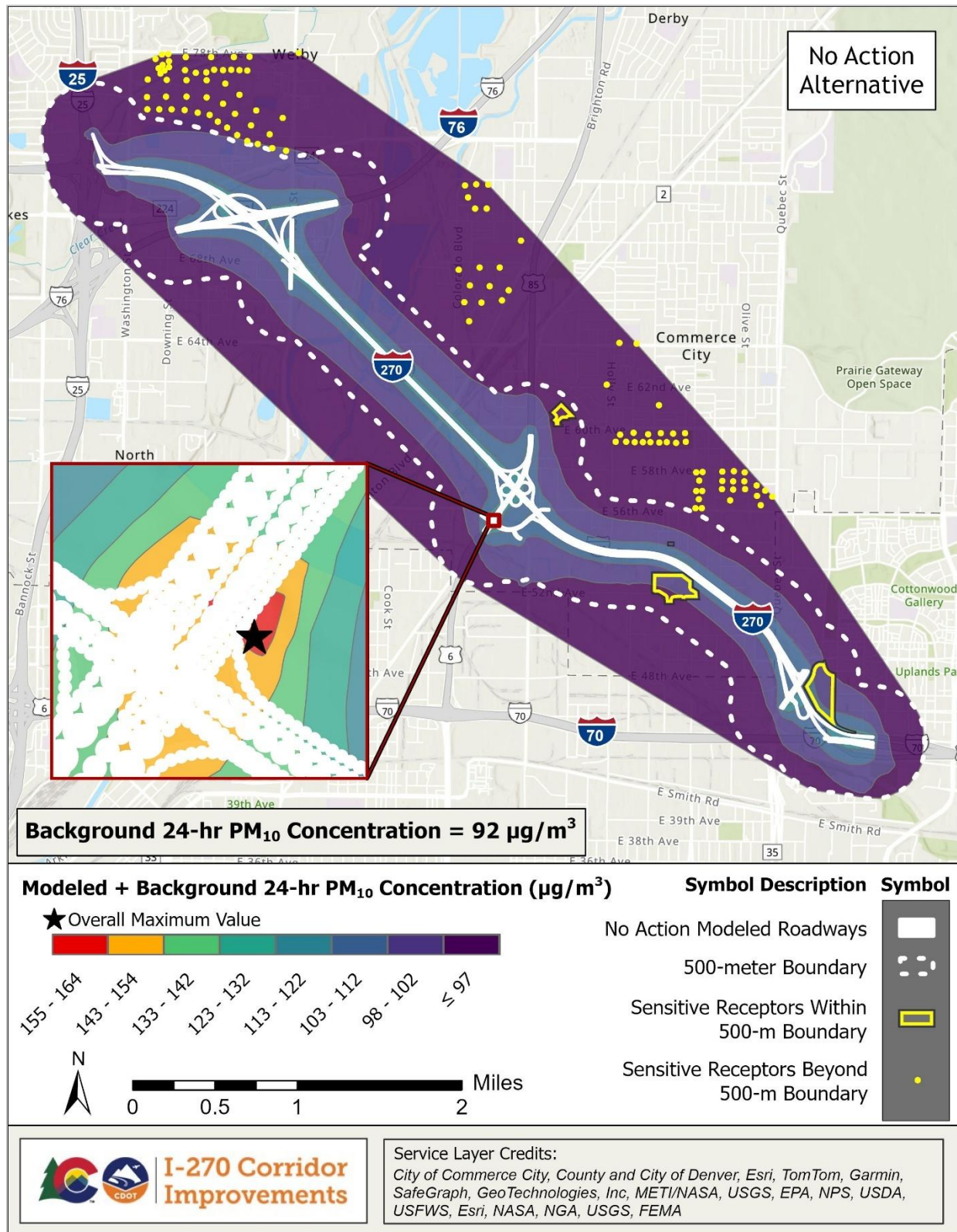


Figure 11. Contour Plot of 24-hour Average PM₁₀ DCs (Before Rounding) and the Location of the Maximum DC (on the South Platte River Trail at I-270) in the 3GPL Alternative

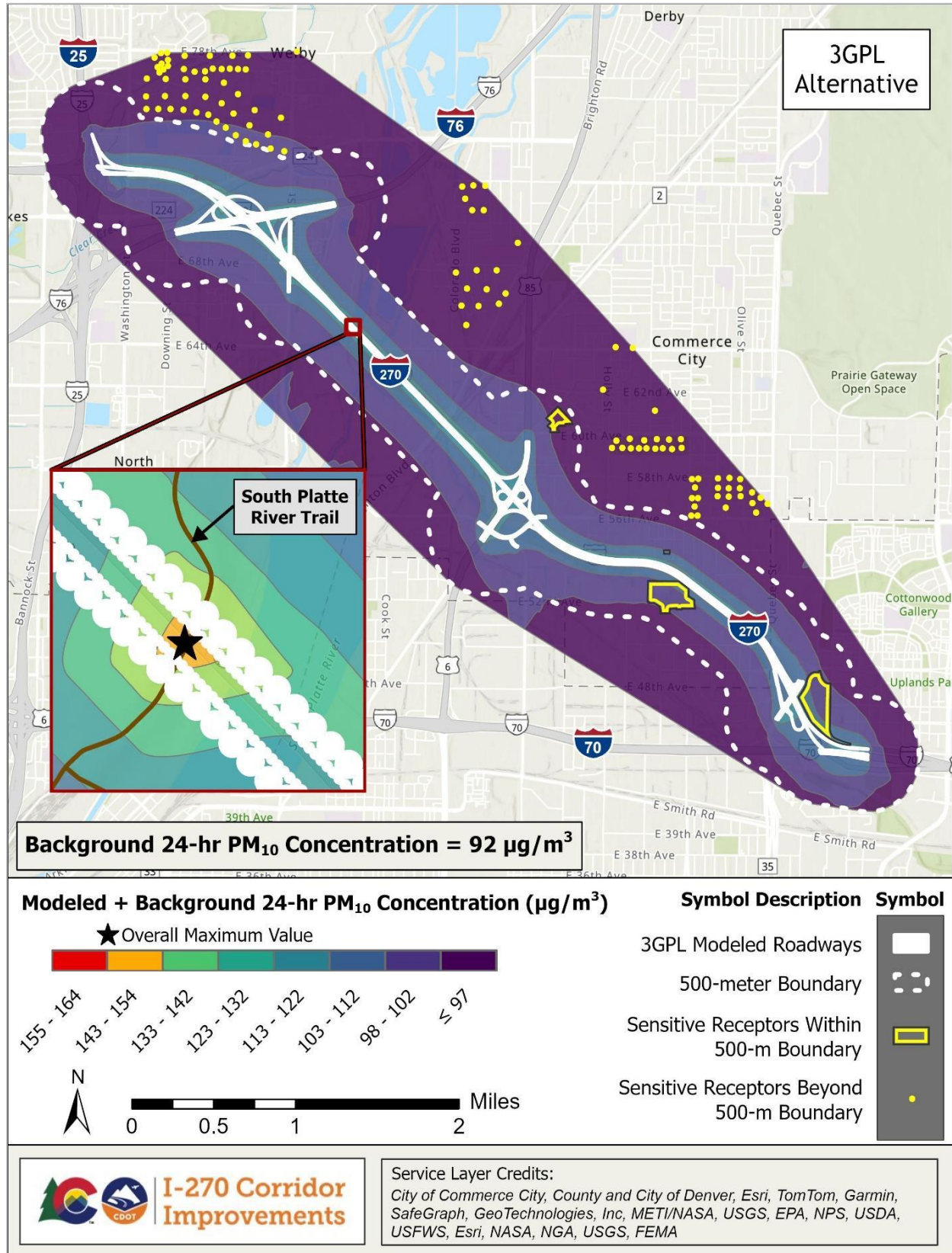


Figure 12. Contour Plot of 24-hour Average PM₁₀ DCs (Before Rounding) and the Location of the Maximum DC (at the Vasquez Boulevard/East 56th Ave Intersection) in the 2GPL+1EL Alternative

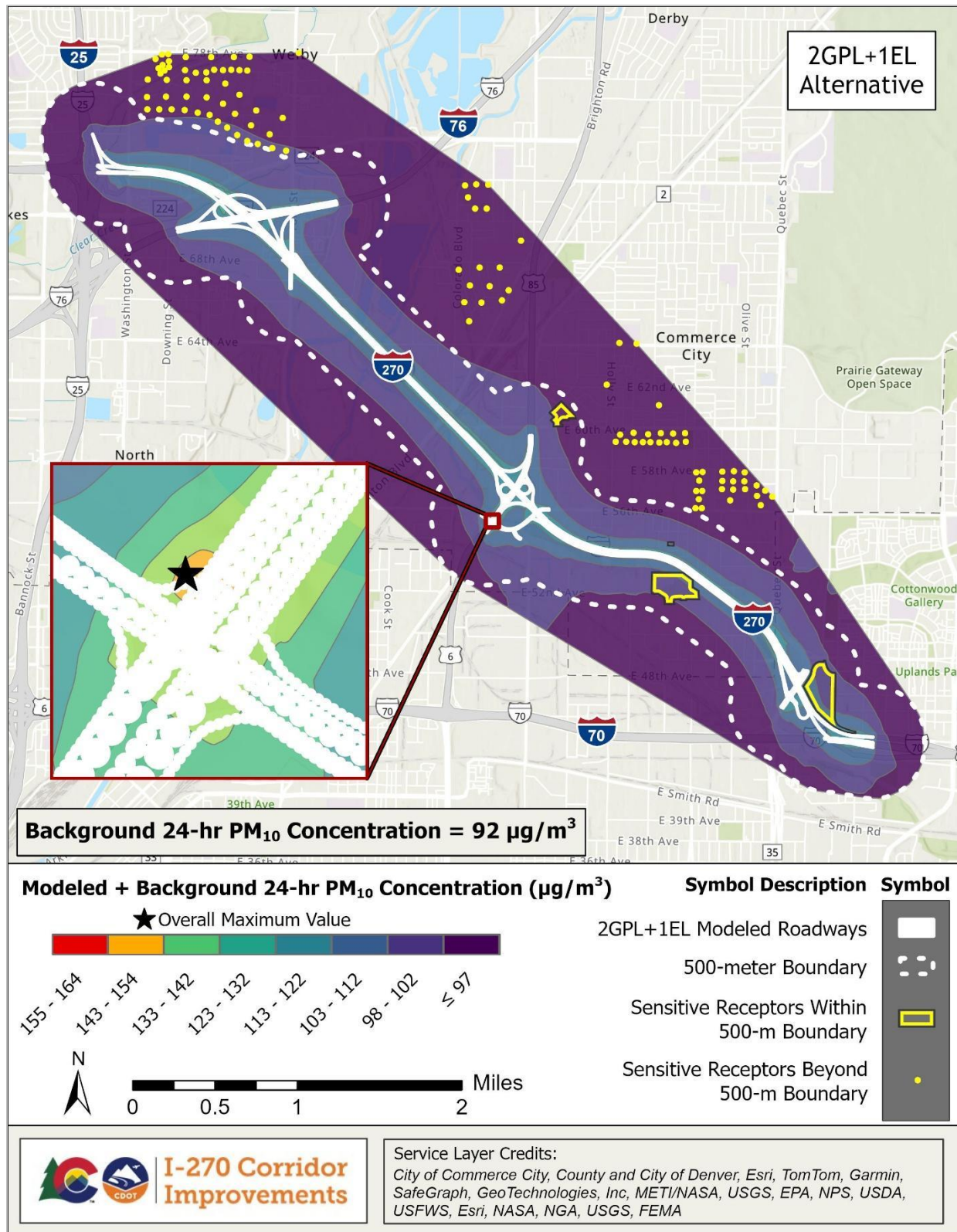


Figure 13. Contour Plot of 24-hour Average PM_{2.5} DCs (Before Rounding) and the Location of the Maximum DC (at the Vasquez Boulevard/East 56th Ave Intersection) in the No Action Alternative

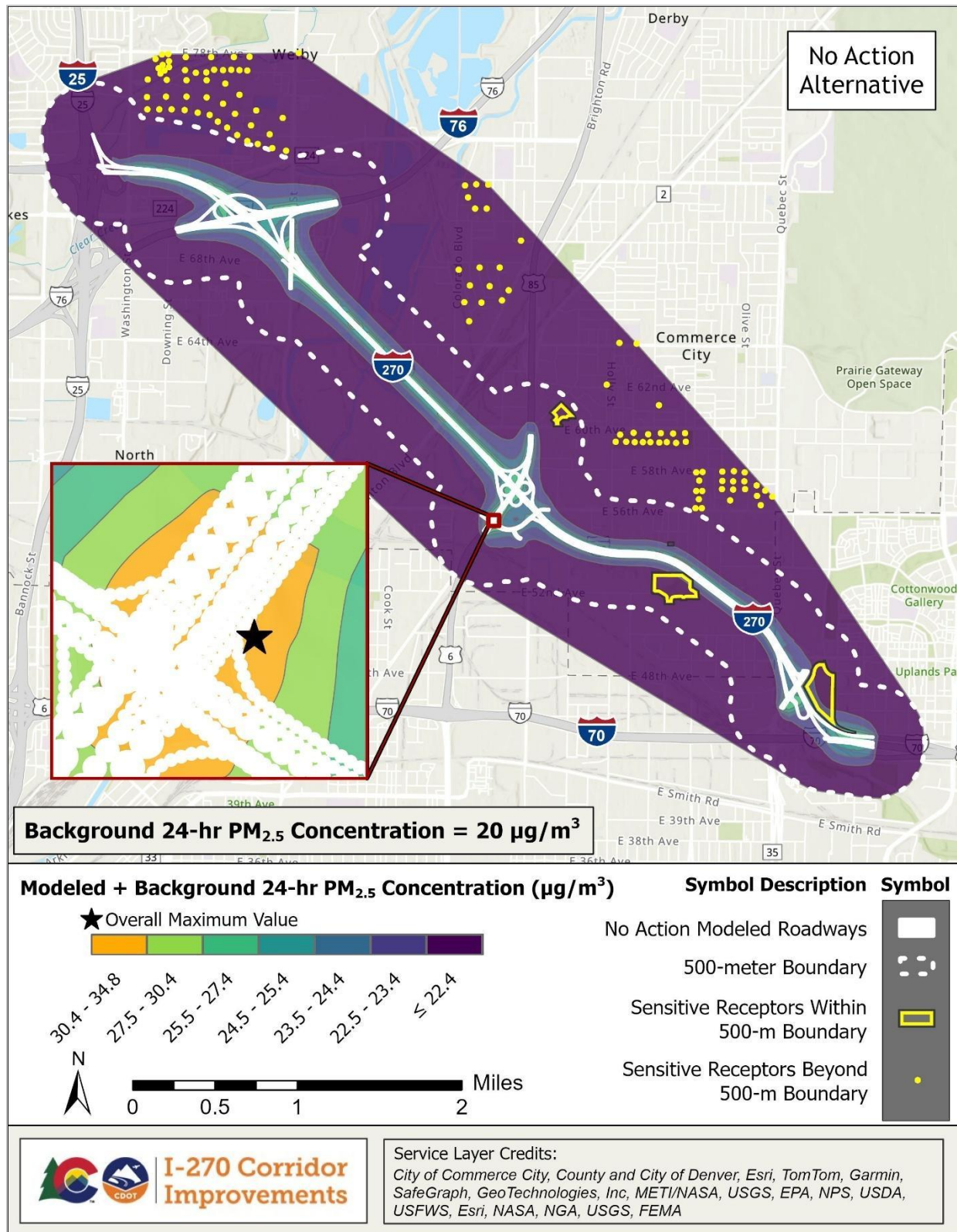


Figure 14. Contour Plot of 24-hour Average PM_{2.5} DCs (Before Rounding) and the Location of the Maximum DC (on the South Platte River Trail at I-270) in the 3GPL Alternative

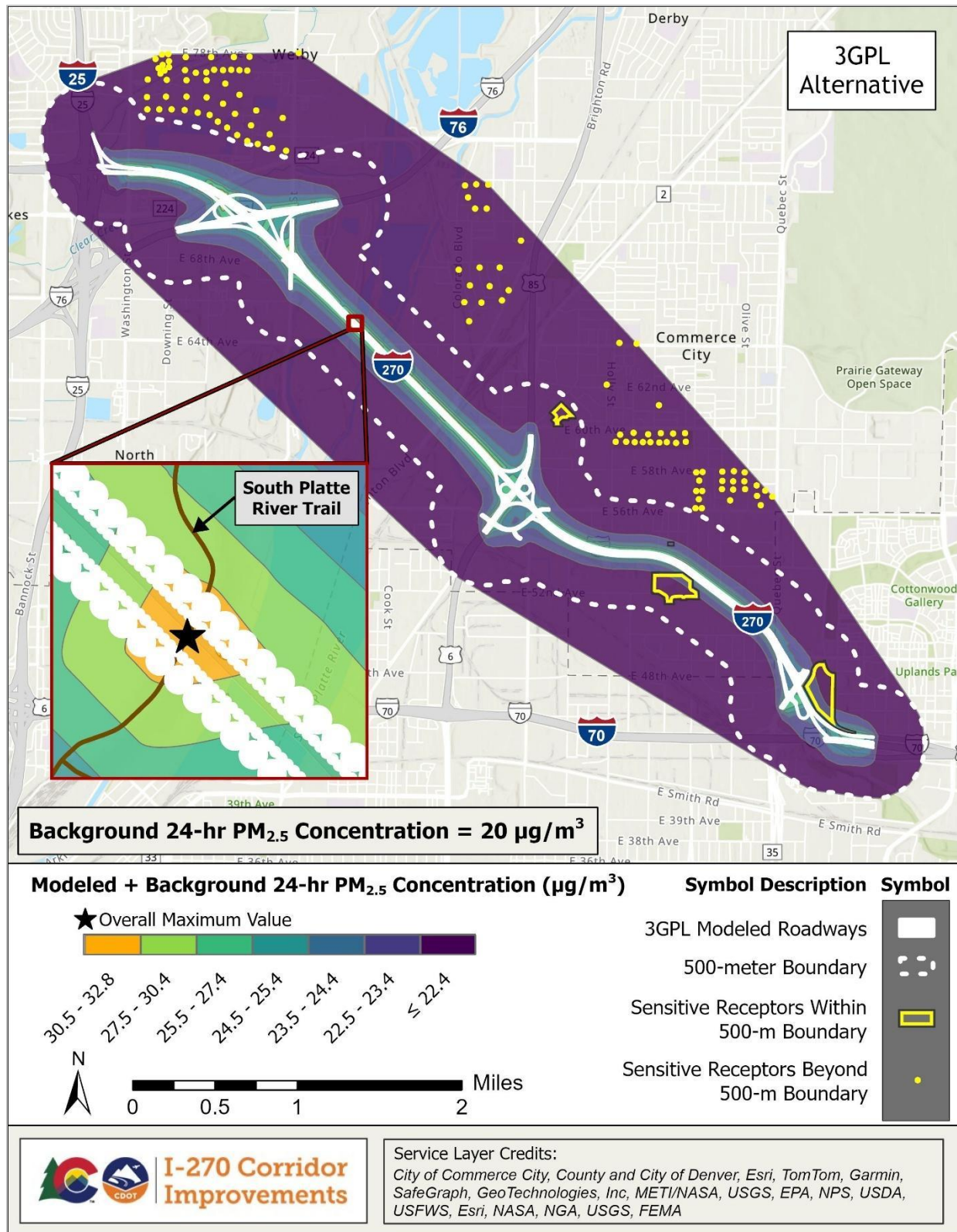


Figure 15. Contour Plot of 24-hour Average PM_{2.5} DCs (Before Rounding) and the Location of the Maximum DC (at the Vasquez Boulevard/East 56th Ave Intersection) in the 2GPL+1EL Alternative

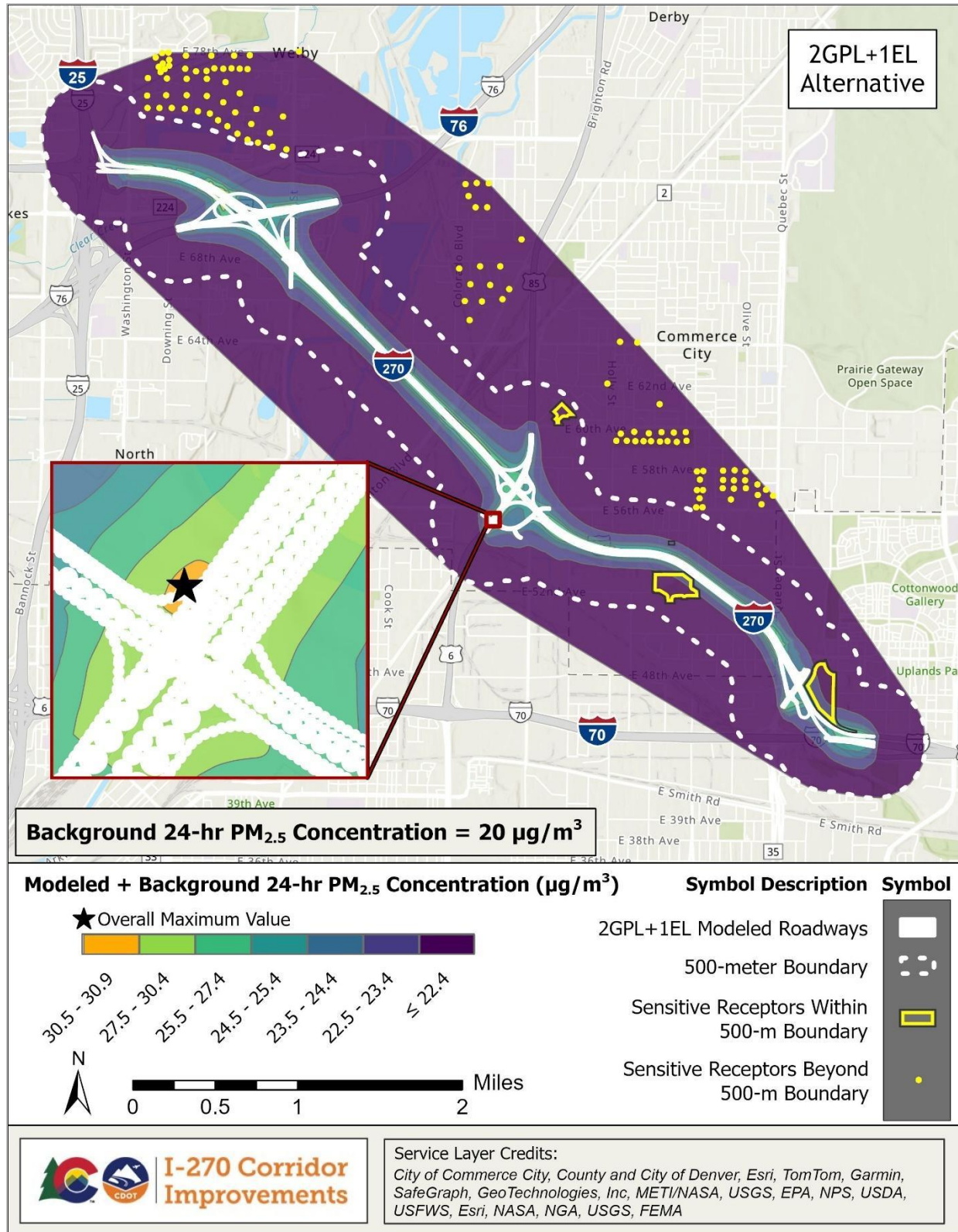


Figure 16. Plot of Annual Average PM_{2.5} DCs (Before Rounding) and the Location of the Maximum DC (at York Street Between East 68th Place and East 69th Place) in the No Action Alternative

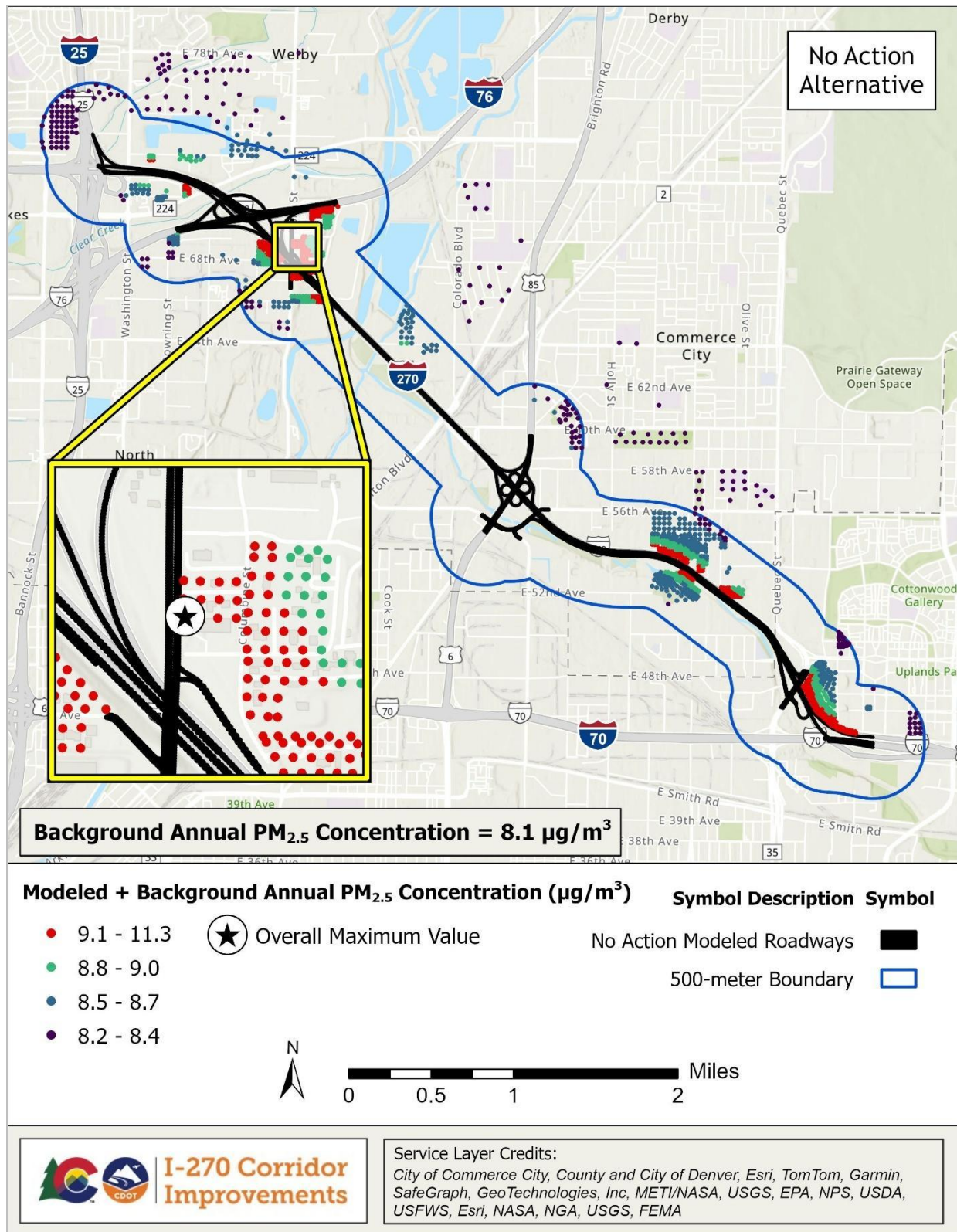


Figure 17. Plot of Annual Average PM_{2.5} DCs (Before Rounding) and the Location of the Maximum DC (at York Street Between East 68th Place and East 69th Place) in the 3GPL Alternative

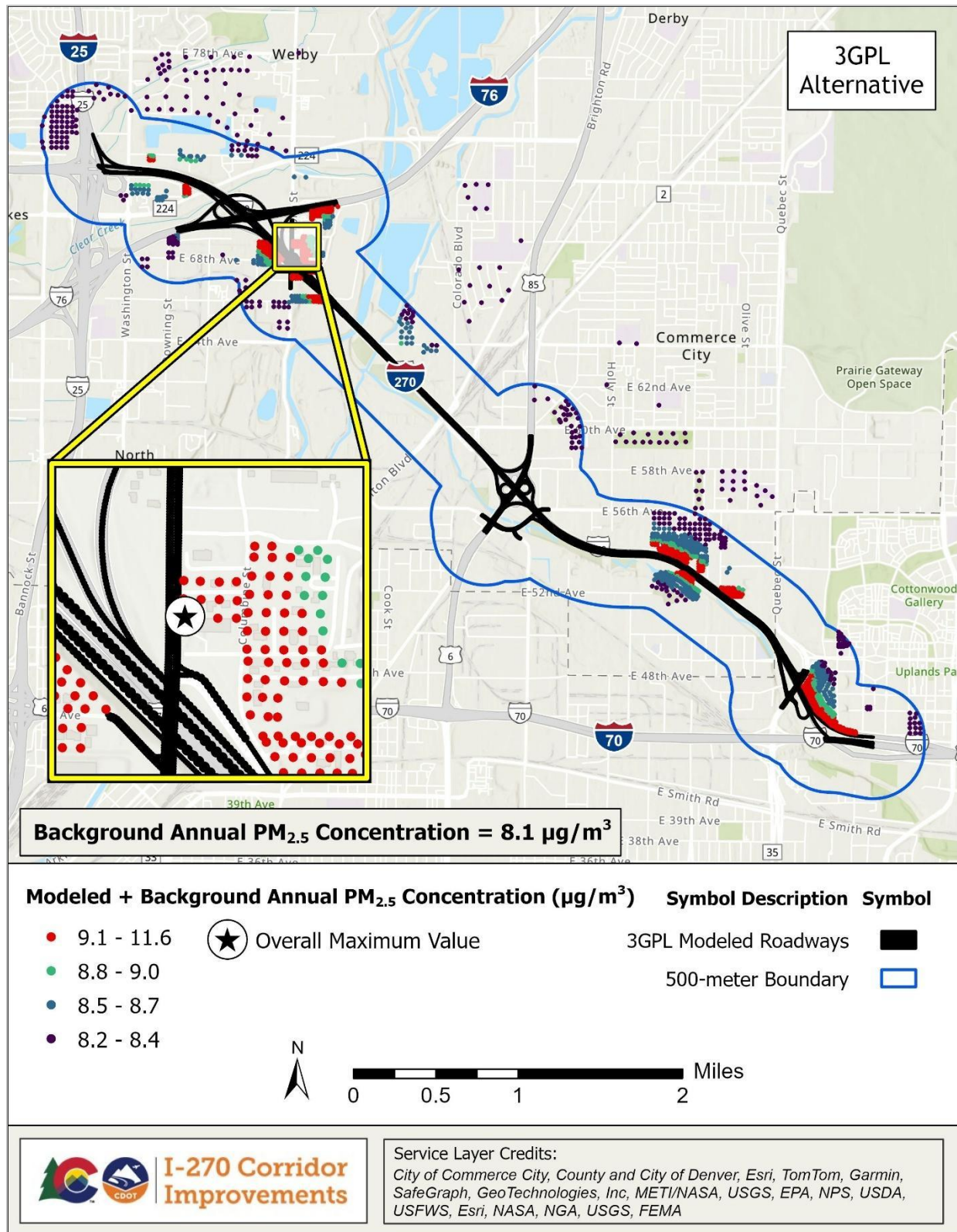
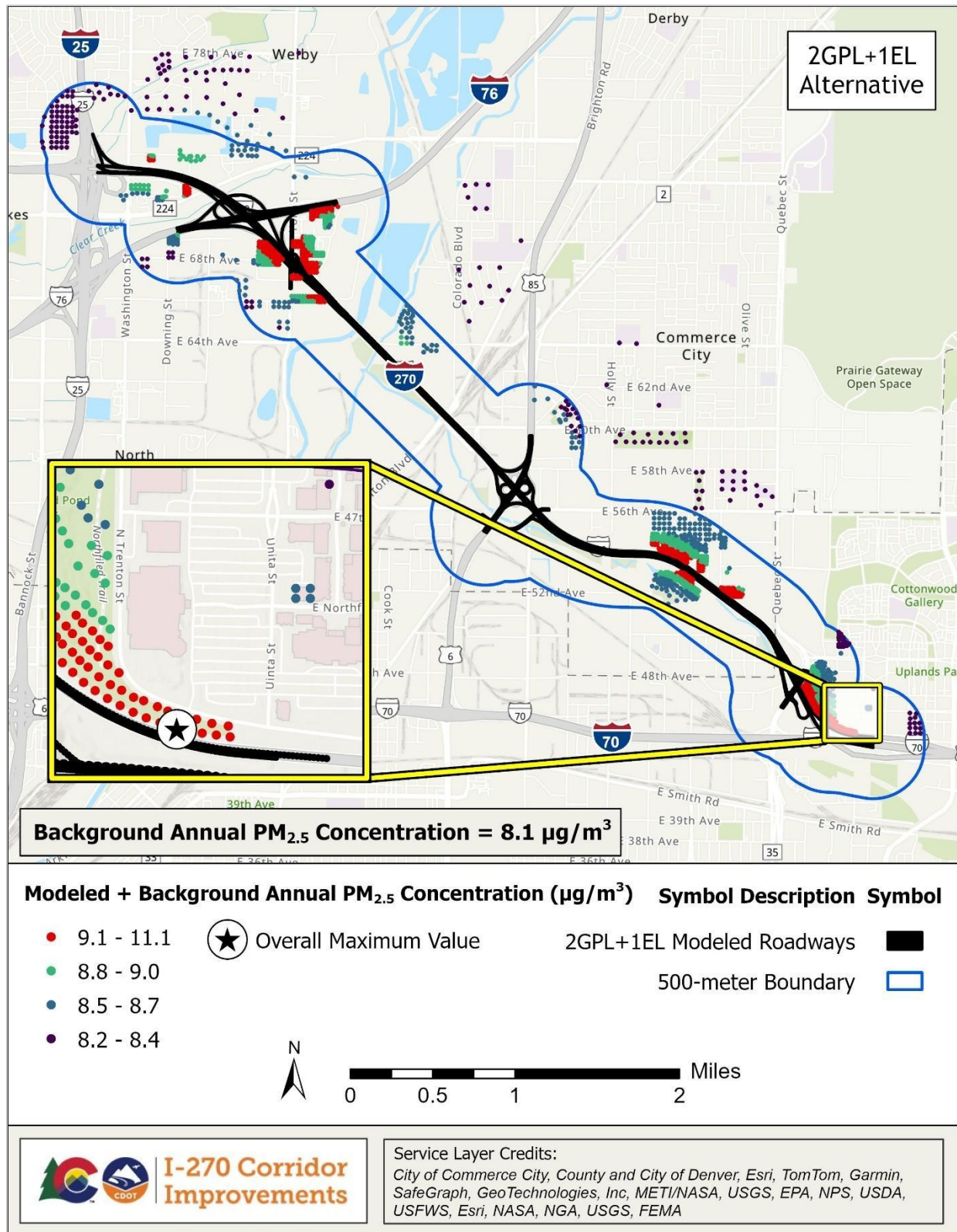


Figure 18. Plot of Annual Average PM_{2.5} DCs (Before Rounding) and the Location of the Maximum DC (at Northfield Pond Park between East 45th Avenue and I-270) in the 2GPL+1EL Alternative



7.5 Qualitative Analysis of 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 (PM₁₀ and PM_{2.5}) in the study area. Sources of fugitive dust (PM₁₀ and PM_{2.5}) during project construction would include disturbed surface areas at the construction site and trucks carrying uncovered loads of soil and 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, the silt content of soil, wind speed, and the number of operating construction vehicles.

Exhaust emissions during construction would be generated by fuel combustion in motor vehicles and construction equipment. Construction vehicles and the 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. Measures to control construction emissions under federal requirements are discussed under separate cover in the air quality technical report for the EIS.

8.0 VMT and Associated Emissions Changes on Other Alternate Routes

The Project emissions study area was generally defined following existing project-level air quality analysis guidance. The purpose of project-level air quality analysis is to isolate the modified corridor to evaluate whether localized air quality impacts, e.g., elevated concentrations of traditional air pollutants, could result from a planned action as compared to the No Action Alternative. For this supplemental analysis documented in the section, Criteria Air Pollutants, MSATs and emissions were not quantified or directly compared as they relate to VMT. Under this guidance, the inclusion of roadways that are not proposed to be modified under an alternative are generally discouraged in an emissions analysis. Furthermore, the build alternative travel demand models used in the emissions analysis did not include planned, directly connected projects to I-25, US 36 and I-70 Express Lanes on either end of the corridor to provide a conservative estimate of emissions on I-270. However, these projects are included in DRCOG's 2050 RTP and are expected to eliminate bottlenecks at either end of the I-270 corridor resulting in smoother and less congested operations on the highway as well as likely associated emissions decreases. The I-270 Air Quality Work Plan located in Appendix A provides additional detail on the methodology and inputs for the operational emissions analysis.

The Project emissions study area (Figure 2) largely includes only Project roadways except for smaller subsets of non-project roadways, also referred to as off-project links, at proximity to where they physically interrelate with the Project roadway. Please refer to the I-270 Air Quality Work Plan located in Appendix A for detail on how roadways included in the operational emissions analysis were selected. VMT is predicted to increase for all Project alternatives by 2050, reflecting anticipated regional population and employment growth incorporated into the model. Higher traffic volumes, increased daily VMT, and associated increases in operational emissions were projected for the Project build alternatives (3GPL and

2GPL+1EL) compared to the No Action Alternative due to the addition of a lane in both directions, which increases corridor capacity, albeit to different extents.

It is expected when conducting travel demand modeling for a highway expansion to predict increases in VMT and emissions on the expanded roadway compared to the No Action Alternative. The travel demand modeling data used in the operational emissions analysis focused on the project corridor, independent of the broader regional network impacts. Added capacity on the Project roadways generally results in higher modeled VMT reported within the modified corridor as reduced congestion increases I-270's relative attractiveness for regional trips compared to other, more congested routes outside the area considered in the emissions analysis.

Some of this modeled increase in VMT reflects the reassignment of the No Action Alternative vehicle trips that use other routes to avoid congestion on I-270, including longer and more circuitous route choices on I-70 and I-25 as well as trips through local neighborhoods. The corridor level operational emissions analysis and results within this report do not account for the potential reductions in VMT and associated emissions on those other roadways, particularly I-70 and I-25, as drivers elect to travel on less congested and more direct routes on I-270 under either build alternatives.

Most roadways considered as alternate routes other than I-270 were not included in the project emissions study area as they are not proposed to be physically altered within the scope of project elements under an alternative. The exception is subsections of some smaller roads associated with some alternate routes which were included in the emissions study area, e.g., Vasquez Boulevard. However, the geographic extents of these roads were highly constrained within the emissions study area to focus on the direct influence of I-270 and the alternatives. Thus, the project emissions study area does not capture the likely effects of travel and related emissions from these other alternate routes within the region.

To supplement the operational emissions analysis within the emissions study area and evaluate how travel behavior would likely change regionally under a given alternative, additional analysis was conducted on the alternate routes to evaluate changes in VMT from roadways that were not initially in the Project emissions analysis. Consistent with the analysis conducted for the Project emissions study area, the same regional travel demand modeling conducted for the Project was used to represent likely travel behavior in 2050 for the No Action and 2GPL+1EL Alternatives for the following roadways that comprise some of the alternate routes near I-270, but were either fully (or partially) excluded from the Project emissions study area:

- 38th Street
 - 47th Avenue
 - 56th Avenue
 - Brighton Boulevard
 - Central Park Boulevard
 - Colorado Boulevard
 - I-25
 - I-270 Interchanges associated with I-25, I-70, I-76 and US 36
 - I-70
-

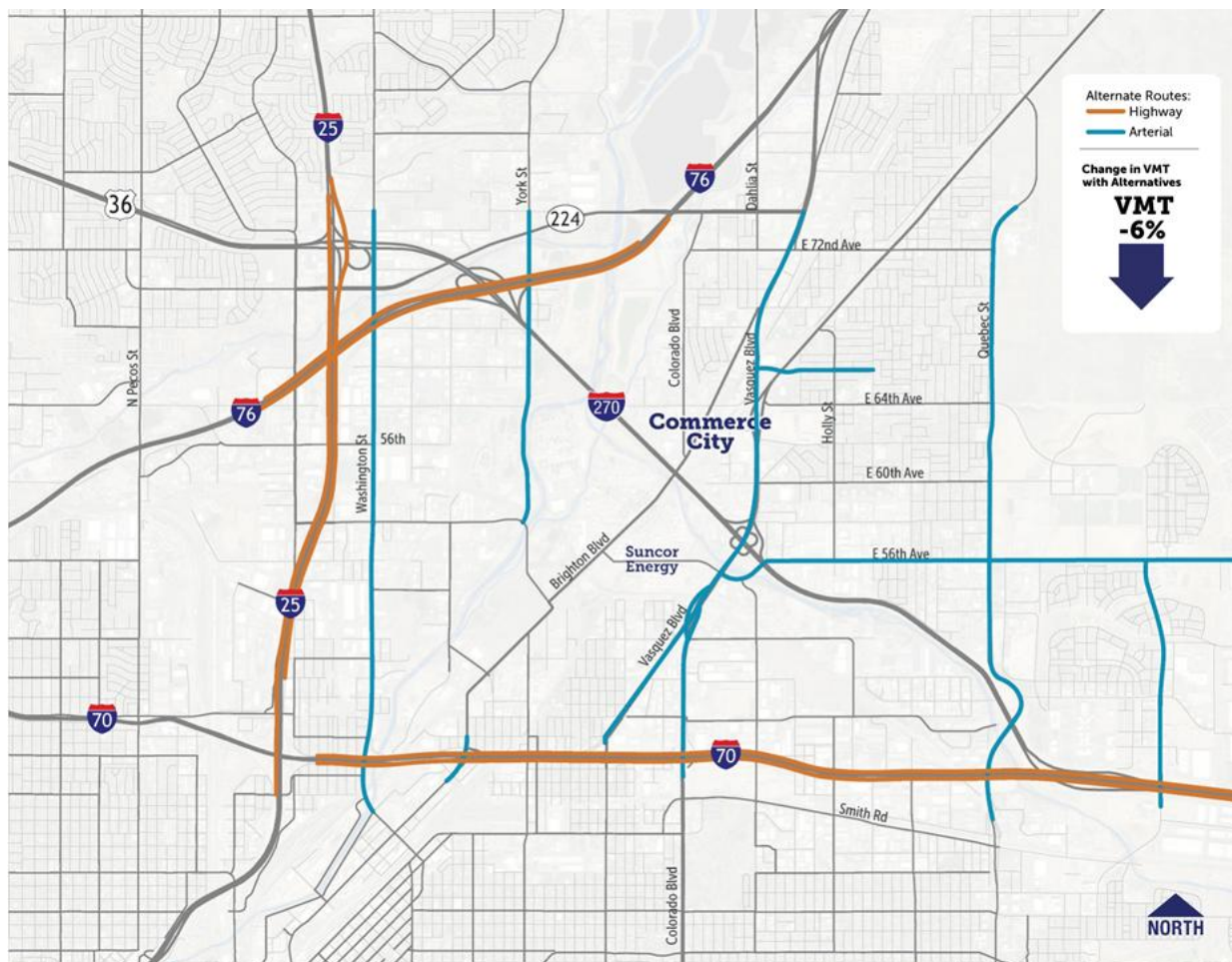
- I-76
- Quebec Street
- Steele Street
- Vasquez Boulevard
- Washington Street
- York Street

These roadways, which remain unchanged between alternatives, were extracted from the regional travel demand model and a qualitative analysis was conducted to compare the relative differences in VMT. The predicted travel behavior of these roadways was aggregated from the regional travel demand modeling for each alternative. The I-270 project is reflected in DRCOG's 2050 RTP. Notably, both build alternatives in this qualitative supplemental analysis do not include the planned, direct connect projects to I-25, US 36 and I-70 Express Lanes on either end of the corridor that are reflected in DRCOG's 2050 RTP. As directed by FHWA, these projects are included in the No Action Alternative model to reflect the most conservative air quality analysis results.

Direct Connects refer to Express Lane-to-Express Lane ramps between interstate facilities that provide regional Express Lane continuity. The I-270 Project 2GPL+1EL Alternative includes Express Lanes as part of the recommended improvements on I-270; however, it does not include the Express Lane Direct Connects to the I-25/US 36 and I-70 Express Lanes on the west and east ends of the corridor, respectively. The I-25/US 36 and I-70 Express Lane Direct Connect projects are included in the regional travel demand model as anticipated, stand-alone projects separate from the Corridor I-270 Improvements Project. The I-270 Express Lane benefits are projected to be maximized when coupled with the I-25/US 36 and I-70 Direct Connect projects, as these connections would allow for seamless Express Lane travel across multiple corridors in the regional network. Excluding the direct connects from the air quality analysis conservatively ensures that the potential emissions are not underestimated. The timing, funding and sequencing of these improvements relative to the I-270 Improvements Project are still under development at this time, therefore, these external improvements were conservatively excluded from the comparative air quality emissions analysis. As a result, the travel modeling of the build alternatives captures the projected increases in VMT associated with the added lanes in each alternative, and reduced corridor travel speeds compared to those anticipated to exist with the direct connections to the other routes.

Figure 19 shows the map of alternate routes that were included in the VMT analysis, as well as the total predicted change in VMT in 2050 between the 2GPL+1EL Alternative relative to the No Action Alternative on these roadways. VMT on these alternate routes are predicted to decrease under the 2GPL+1EL Alternative relative to the No Action Alternative by approximately 6%. However, the alternate routes analysis only focused on VMT and did not directly quantify associated criteria pollutant and MSAT emissions decreases. The reductions in VMT are due to a greater number of drivers choosing to travel on more direct routes with a less congested I-270 under the 2GPL+1EL build alternative. It is reasonable to expect that criteria pollutants and MSAT emissions will also decrease on these alternative routes due to the VMT reduction.

Figure 19. Alternate Routes Included in the VMT Analysis and Predicted Change in VMT in 2050 between the 2GPL+1EL Alternative relative to the No Action Alternative

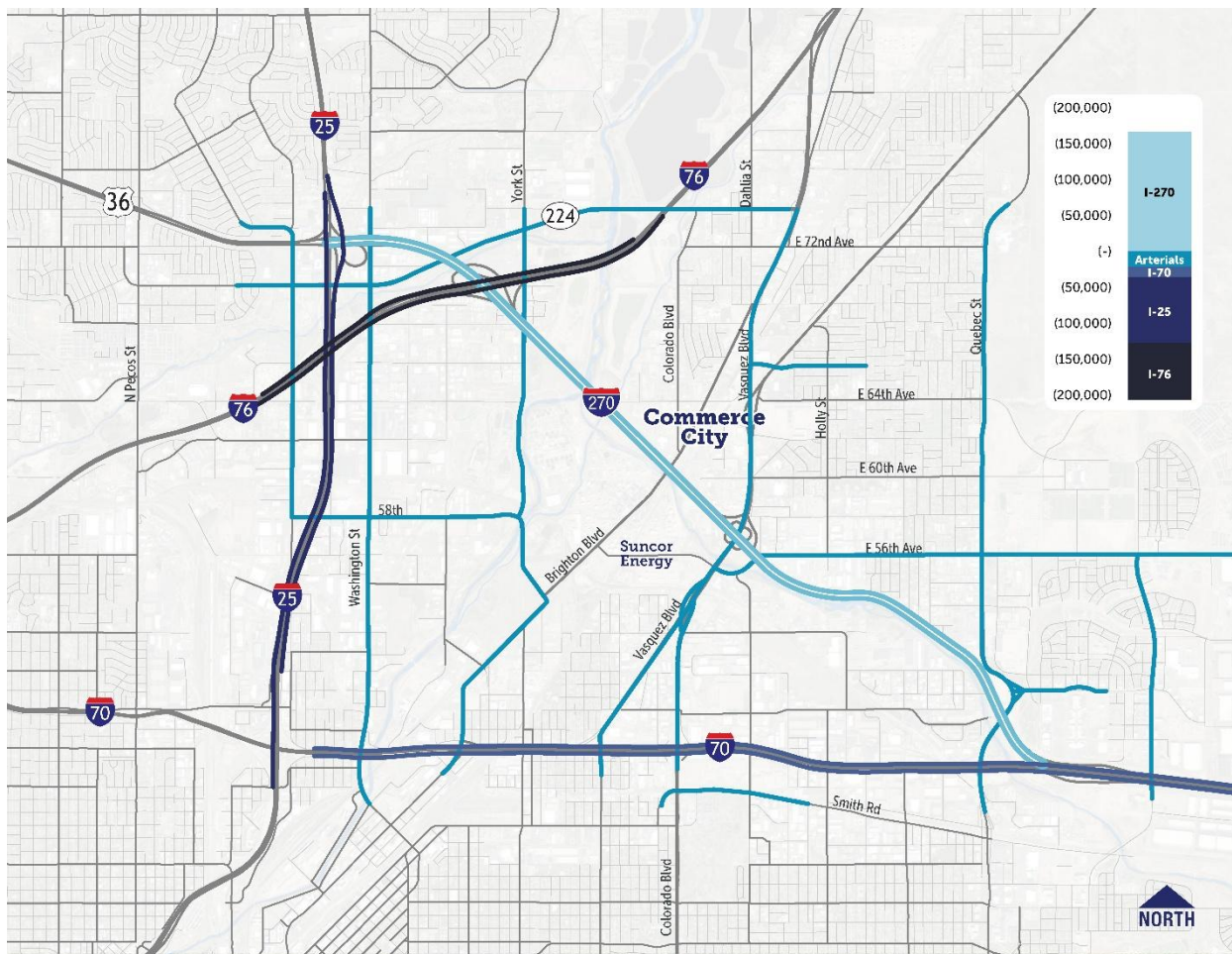


The interstates associated with alternate routes other than I-270 in the region (shown in orange on Figure 19) are all predicted to have decreases in travel and VMT. The predicted reductions in VMT also contribute to overall emissions reductions on these alternate routes. In addition to predicted decreases in VMT on alternate interstate routes other than I-270 in the region under the build alternatives, there is also a predicted decrease in vehicle travel on smaller arterial roads within the neighborhoods of the Project area. This not only results in decreases in VMT and associated emissions, but it also provides a significant safety benefit to the public in the Project area who will experience less traffic near locations such as residences and schools as drivers would elect to travel on the more efficient I-270 than local roads when traveling through the area. A reduction in commercial vehicles on these neighborhood streets is particularly beneficial in this regard, reducing sources of emissions near residences, schools, and other sensitive receptors. The Project corridor is largely built out with a mix of industrial, commercial, and residential land uses, so the proposed Build Alternatives are not expected to induce substantial new development or land-use changes that would generate additional long-term travel demand (often referred to as “induced demand”). Accordingly, it is important to interpret corridor-level VMT projections within the broader context of the regional transportation network and related projects. Although VMT is

projected to increase on I-270 under the No Action and build Alternatives, this increase primarily represents a redistribution of regional travel demand rather than new, induced travel resulting from changes in land use or trip frequency.

Figure 20 shows the relative changes in VMT between the No Action and the 2GPL+1EL Alternatives for I-270, which include the surrounding interstates and major local roads. Overall, the 2GPL+1EL alternative will reduce VMT on alternate routes to a greater extent than VMT is predicted to increase on I-270, relative to the No Action alternative. This result demonstrates that regional VMT is not predicted to increase as a direct result of the 2GPL+1EL build alternative. Consequently, the Project expansion is not anticipated to be a significant source of regional induced demand (i.e., more frequent/longer trips or changes in land use).

Figure 20. Relative Changes in VMT between the No Action and 2GPL+1EL Alternatives



The *I-270 Corridor Improvements Project Environmental Impact Statement Traffic Technical Report* (CDOT 2025a) analyzed and predicted changes in VMT at the regional level, including the effects of direct connections for both the No Action and 2GPL+1EL alternatives. This provides a more accurate representation of likely future roadway conditions in and around the Project area. The *Traffic Technical Report* provides a comprehensive assessment of the corridors and overview of anticipated impacts to regional traffic operations. The analysis

documented in the *Traffic Technical Report* includes results from the regional travel demand model as well as detailed microsimulation modeling that incorporates the planned direct connection improvements between I-270, I-25, US 36, and I-70. The travel modeling approach in the *Traffic Technical Report* is consistent with federal requirements for evaluating traffic impacts under NEPA and should be referred to for more accurately assessing likely future changes in travel behavior on the transportation network in the region. Similarly, the *Traffic Technical Report* demonstrates that the build alternatives are projected to increase VMT on I-270 relative to the No Action Alternative. These VMT increases on I-270, however, correspond with improved operational performance and reduced congestion throughout the broader regional system once the direct connections and improvements on I-270 are in place, as well as related decreases in VMT on other interstates and roadways in the region that connect to I-270.

9.0 Air Quality Commitments

CDOT commits to supplemental state enhancements to reflect the goals of CRS 43-1-128 by meaningfully involving the community and addressing local priorities that go above and beyond design elements and EIS mitigations. CDOT would use state funds to implement these enhancements that are identified through a community-driven process. For a full list of enhancements that CDOT is committed to providing and details of each, please see Appendix B of the *State Community Analysis Report* for the I-270 Corridor Improvements Project (CDOT 2025b).

CDOT commits to the following enhancements that would provide benefits to air quality³³:

- Develop and provide enhanced air quality monitoring before, during, and after construction while partnering with local agencies to collaborate and share the monitoring data across networks, including via a real-time, mobile-friendly air quality dashboard.
- Development and implementation of a particulate matter 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.
- Development and implementation of 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 particulate matter pollution.
- Provide funding for multimodal improvements on Colorado Highway 224, including sidewalks for safer pedestrian movement.
- Implement transportation demand management (TDM) strategies via the local Transportation Management Organization, Northeast Transportation Connections (NETC). Examples of TDM strategies employed by NETC include e-bike tax credits, free transit passes, and assistance with finding carpools or vanpools to join.
- Continue the air quality monitoring project prior to construction to provide continuous monitoring data for the area.

³³ Note that additional enhancements may also be considered throughout the project development process, so the enhancements are not limited to those in this list.

- Provide match funding for the Reconnecting Communities Planning Grant, which will improve multimodal connections along 60th Avenue between Brighton and Vasquez Boulevards.
- Assist with funding and coordinating the installation of landscaping and trees both within and beyond the project limits. The installation of trees and landscaping can help absorb particulate matter and other pollutants.
- Collaborate with, participate in, and financially support local agency projects and other projects outside the I-270 limits that enhance community well-being by promoting improved safety, multimodal options, environmental and regional air quality improvements, community development, and/or alternative energy solutions to serve those most affected by the I-270 project. This could include partnering with other agencies on regional air quality improvement projects or working with agencies to evaluate/prioritize route changes or other transit service on I-270.
- Implement enhanced measures beyond standard CDOT practices to improve safety, mobility, and incident response within the construction work zone. This could include implementing a tow truck patrol system to quickly clear crashes to reduce idling.

10.0 Conclusions

The I-270 state-only air quality analysis was performed to further evaluate current and future total emissions of criteria pollutants and MSATs of the three alternatives considered in the Draft EIS through an emissions inventory. An analysis of potential future ambient concentrations of particulate matter (PM_{10} and $PM_{2.5}$) and carbon monoxide (CO) was performed through an air quality dispersion model for all alternatives, including the No Action Alternative. This model was designed to be as accurate as possible; however, several conservative assumptions were also incorporated in the hotspot analysis, meaning it is more likely to over-predict impacts than under-predict them.

The project area is currently in attainment for particulate matter for both PM_{10} and $PM_{2.5}$. Real-world air quality monitors in and around the project area confirm that particulate matter concentrations are currently below the NAAQS and generally are trending downward in recent years. Furthermore, the near-road particulate monitors in the project area have measured concentrations below the background concentrations provided by the APCD that are only slightly below the current NAAQS.

The I-270 emissions inventory demonstrates that as a result of cleaner vehicle technologies and cleaner fuels, future emissions of most criteria pollutants and MSATs are expected to significantly reduce by the design year 2050, despite projected growth in VMT. The exception is PM_{10} , which is predicted to have an increase in total emissions relative to the other pollutants. PM_{10} is predicted to increase in future years due to road dust emissions that are included in the analysis for this pollutant which is directly proportional to VMT. However, future ambient concentrations that include road dust attributable to increases in VMT, were predicted to be at or lower than clean air standards for PM_{10} for the near-road hotspot modeling that was performed for all alternatives. The near-road hotspot modeling, which predicts these ground-level concentrations, showed that even with the increase in VMT, future ambient concentrations of PM_{10} were predicted to remain at or below the clean air standards for all project alternatives.

There are limitations and uncertainties associated in any modeling analysis that is intended to evaluate future conditions. The I-270 state air quality analysis was designed to represent a conservative estimate of future conditions based on several model inputs and assumptions such as intentionally not including future planned projects that interrelate with the I-270 expansion, such as connections with I-25, US 36 and I-70. Including these planned improvements on I-270 would likely result in positive changes to vehicle operations and associated emissions by providing more direct and less congested route options for travel. This would more accurately represent future roadway conditions and associated VMT that may have resulted in lower predicted future concentrations.

For the project air quality analysis, traffic conditions were modeled under a scenario that assumed the build alternatives operate without the I-25/US 36 and I-70 Direct Connects projects in places, to represent a worst-case, more congested condition. This conservative assumption captures the highest potential congestion and idling levels that could occur if construction timing results in a temporary gap in regional Express Lane continuity, ensuring the analysis does not underestimate potential emissions or localized air quality impacts.

Not including direct connections in the travel demand modeling used in the emission analysis resulted in EPA's MOVES model assigning higher PM emissions rates associated with congestion, particularly a greater level of braking and acceleration events that increase emissions from brake and tire wear as well as higher tailpipe emissions resulting from reduced speeds. Notably, brake and tire and wear emissions do not significantly change in future years as they are not strictly impacted by federal fuel economy standards, but are sensitive to changes in speeds and associated congestion within MOVES. Conversely, including direct connections used in the travel modelling for the emissions analysis would likely result in changes to VMT that would affect emissions, particularly for PM₁₀.

Other assumptions in the modeling that were included in AERMOD specific to the air quality dispersion modeling in order to not underpredict future concentrations include:

- The use of volume sources to represent roadways in AERMOD. Research on the accuracy of AERMOD by comparing modeled concentrations to real-world measured concentrations in the same locations has indicated that using volume sources to represent a roadway in AERMOD, which was done in this analysis, sometimes resulted in overpredicting ambient concentrations attributable to mobile sources near roadways in other areas.
- The use of flat terrain in AERMOD. EPA in their published project-level hotspot guidance for modeling roadway concentrations that analysis should typically begin with assuming flat terrain in the project area in AERMOD, which was done for this analysis to not underestimate concentrations. However, EPA also notes that in some instances considering terrain effects is appropriate and that the AERMAP model option to include terrain effects can be incorporated on a case-by-case basis via interagency consultation. At the time the state analysis was scoped FHWA directed that the analysis should begin with flat terrain assumption representing a conservative approach in estimating future ambient concentrations. As discussed in Section 7.4.2, the terrain in the project area is known to be complex and characterizing the variation in elevation differences throughout the modeling domain would most likely have resulted in lower model estimated concentrations.

The No Action Alternative is predicted to have highest ambient design concentrations of 24-hr PM_{10} and 24-hr $PM_{2.5}$ across the alternatives in the near-road, hotspot modeling. This is likely due to increased levels of congestion without a highway expansion, resulting in higher vehicle emissions in the project area. The 2GP+1EL and 3GP alternatives predict the same design concentrations for 24-hr PM_{10} while the 2GP+1EL alternative is predicted to have the lowest $PM_{2.5}$ ambient design concentrations in future years for both 24-hr and annual $PM_{2.5}$ concentrations. The 3GP alternative is predicted to have the highest annual $PM_{2.5}$ concentrations in the near-road modeling.

When evaluating the hotspot modeling results, consideration should be given to existing actual particulate matter concentrations that are being measured at values below the NAAQS, as well as the expected decrease in future mobile source emissions of $PM_{2.5}$. These considerations, in conjunction with other independent studies evaluating AERMOD's performance in predicting near-road concentrations with similar conservative model assumptions and inputs that were incorporated in the I-270 state-only air quality analysis consistently across all the alternatives, indicate that the hotspot analysis may result in overpredicting absolute future concentrations in the project area. Thus, rather than a focus on absolute modeled concentrations that may be overestimated, the hotspot modeling remains a useful tool for comparing alternatives to each other to assess conservatively predicted impacts. In qualitatively comparing the predicted near-road modeled design concentrations between all alternatives, the 2GP+1EL has the lowest predicted concentrations for PM_{10} and $PM_{2.5}$ of the alternatives.

In summary, while the I-270 project is predicted to contribute to localized emissions under implementation of any alternative, including the No Action Alternative, due to the background concentration provided by APCD and the inherent conservatism in AERMOD, the air quality analysis indicate that future predicted impacts may be overestimated. Future emissions of all pollutants are expected to decrease due to cleaner vehicles and technologies, with the exception of PM_{10} . Although emissions of PM_{10} are expected to increase in the future due to likely future increases in VMT, future modeled concentrations of PM_{10} are below the NAAQS even with the conservative approach to the analysis.

The hotspot modeling performed, while a useful tool for qualitatively comparing alternatives, may be overestimating future pollutant concentrations due to deliberate and conservative assumptions used in the analysis, such as the use of volume sources and assumption of flat terrain in AERMOD, as well as the exclusion of other interrelated projects that are likely to improve operations on I-270 that may also correspond to likely lower future modeled concentrations. In the comparative analysis, the 2GP+1EL alternative shows lesser impacts compared to both the No Action and 3GP alternatives. Moving forward the project will incorporate best management practices during construction to control dust and minimize temporary localized impacts from construction related pollutants.

Furthermore, CDOT Region 1's Community Enhancements Fund supports community-recommended projects that go beyond the required EIS mitigations. Guided by a subcommittee and aligned with Colorado Revised Statute (CRS) 43-1-128(6), these enhancements are chosen to reflect local priorities and provide meaningful benefits. The Community Enhancements will be identified and prioritized as engagement with the

subcommittee and members of the public proceed and will continue into the construction phase of the project.

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Appendix A. Air Quality Analysis Work Plan

CDOT is dedicated to providing an accessible experience for everyone. While we are continuously improving our standards, some complex items in this document, such as certain figures and images, are difficult to create with fully accessible parameters to all users. If you need help understanding any part of this document, we are here to assist and have resources to provide additional accessibility assistance to any requests. Please email us at CDOT_Accessibility@state.co.us to request an accommodation, and a member of our I-270 Engineering Program will schedule a time to review the content with you. To learn more about accessibility at CDOT, please visit the [Accessibility at CDOT webpage on the CDOT Website](#).

The Air Quality Analysis Work Plan is included here.



I-270 Corridor Improvements

Air Quality Analysis: Work Plan

July 11, 2024

Federal Project No.
STU 2706-046

CDOT Project Code
25611



I-270 Corridor Improvements Environmental Impact Statement

Acronyms and Abbreviations

Acronym/Abbrev.	Definition
AERMET	AERMOD meteorological preprocessor
AERMOD	American Meteorological Society/Environmental Protection Agency Regulatory Model
APCD	Air Pollution Control Division
AQ-PLAG	Air Quality Project-Level Analysis Guidance
AQS	Air Quality System
ATR	Automated Traffic Recorder
AVFT	Alternate Vehicle Fuel and Technology
CAA	Clean Air Act
CAP	criteria air pollutant
CDOT	Colorado Department of Transportation
CDPHE	Colorado Department of Public Health and Environment
CFR	Code of Federal Regulations
CH ₄	methane
CO	carbon monoxide
CO ₂	carbon dioxide
CO ₂ e	CO ₂ -equivalent
C.R.S	Colorado Revised Statutes
DPM	diesel particulate matter
DRCOG	Denver Regional Council of Governments
EF	emission factor
EIS	Environmental Impact Statement
EPA	U.S. Environmental Protection Agency
FAQ	frequently asked question
FHWA	Federal Highway Administration
HPMS	Highway Performance Monitoring System
I-270	Interstate 270
I-76	Interstate 76
I/M	inspection and maintenance
ICE	Infrastructure Carbon Estimator
LCA	life cycle assessment
MOVES	Mobile Source Vehicle Emissions Simulator
mph	miles per hour
MPO	metropolitan planning organization
MSAT	mobile source air toxic
N ₂ O	nitrous oxide
NAAQS	National Ambient Air Quality Standards



I-270 Corridor Improvements Environmental Impact Statement

Acronym/Abbrev.	Definition
NEPA	National Environmental Policy Act
NO ₂	nitrogen dioxide
NO _x	nitrogen oxides
O ₃	ozone
PM	particulate matter
PM ₁₀	PM with diameter equal to or less than 10 micrometers
PM _{2.5}	PM with diameter equal to or less than 2.5 micrometers
PMU	Permit Modeling Unit
POM	polycyclic organic matter
QA	quality assurance
QC	quality control
ROW	right-of-way
RS/TC	regionally significant transportation capacity
RTD	Regional Transportation District
RTP	Regional Transportation Plan
RunSpecs	run specifications
SB	Senate Bill
SIP	State Implementation Plan
TDM	travel demand model
TIP	Transportation Improvement Program
TP	time period
USDOT	U.S. Department of Transportation
VMT	vehicle miles traveled
VOC	volatile organic compound
ZEV	zero emission vehicle

1.0 Introduction

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The Colorado Department of Transportation (CDOT) and Federal Highway Administration (FHWA) are preparing an Environmental Impact Statement (EIS) for the Interstate 270 (I-270) Corridor Improvements project (the Project).³⁴ This document provides a brief overview of the regulatory context for the air quality analysis (**Section 2**); describes the proposed elements and methodology of the air quality analysis for the EIS (**Section 3**); and discusses plans for technical reporting of the analysis (**Section 4**). As described in **Section 2**, the proposed air quality analysis goes beyond state requirements by including detailed modeling elements to evaluate potential project-level air quality impacts of specific concern to the public.³⁵

The proposed air quality analysis includes five major elements:

- A quantitative emissions inventory will be developed for comparative analysis of criteria air pollutants (CAPs) and mobile source air toxics (MSATs) from the Project across the (1) Existing Conditions in 2023 (base year) (2) No Action Alternative in 2050 (horizon year), and (3) selected Build Alternatives in 2050. The selection of Build Alternatives for this detailed analysis will be based on comparative screening. The emissions inventory will be based on travel demand model (TDM) results for the traffic activity data, as developed in the traffic analysis.³⁶
- A qualitative discussion of potential emissions and air quality effects from construction of the Project Build Alternatives selected for detailed analysis, along with potential emissions avoidance, minimization, and control measures, will be provided.
- A quantitative carbon monoxide (CO) hot-spot analysis will be conducted for the worst-performing intersection affected by or included in the Project using base-year emission

³⁴ The purpose of the Project is to implement transportation solutions that modernize the I-270 corridor to accommodate existing and forecasted transportation demands. While addressing the needs of traveler safety, travel time and reliability, transit on the corridor, bicycle and pedestrian connectivity across I-270, and freight operations, a key goal of the Project is to minimize resulting environmental and community impacts.

³⁵ See CDOT's Public Involvement webpage at <https://www.codot.gov/projects/studies/i270study/public-involvement>, where outreach activities for the Project hosted by CDOT are documented and comments from a Public Scoping Meeting held on October 10, 2023, are listed.

³⁶ The TDM data for the air quality analyses are not expected to include the direct connects for I-270 with I-25 at the west end of the corridor and with I-70 at the east end of the corridor, which presents a worst-case scenario in terms of modeling emissions from vehicles in the TDM that are connecting with those other interstates or impacting other traffic links in the Project.

factors (EFs) and horizon-year traffic data for the No Action and selected Build Alternatives. The CO dispersion modeling for this analysis will incorporate the design of the intersection and traffic activity data from microsimulation modeling results for the horizon year.

- A quantitative particulate matter (PM) hot-spot analysis will be conducted for the No Action and selected Build Alternatives (horizon year). The PM dispersion modeling for this analysis will incorporate the project design and modeled traffic activity data from microsimulation modeling results. Both PM with diameter equal to or less than 10 micrometers (PM_{10}) and PM with diameter equal to or less than 2.5 micrometers ($PM_{2.5}$) will be modeled for the PM hot-spot analysis.

2.0 Regulatory Context for the Air Quality Analysis

The purpose of the air quality analysis is to analyze potential impacts associated with the Project through an EIS process in accordance with the state air quality requirements, including the requirements of Colorado Senate Bill (SB) 21-260 and Colorado Revised Statutes (C.R.S.) 43-1-128.

2.1 Environmental Impacts of Regionally Significant/Transportation Capacity Projects

An emissions inventory analysis will be conducted in accordance with C.R.S. 43-1-128(4)(a) requirements for Regionally Significant/Transportation Capacity (RS/TC) projects. The analysis will provide a quantitative comparison of project-level emissions across existing conditions of the I-270 corridor, the No Action Alternative, and the selected Build Alternatives. Emissions inventories for all analyzed scenarios will be developed for the CAPs and MSATs summarized below. Additionally, due to the proximity of some parts of the Project to residential communities and concern from the public about potential air quality impacts from the Project, the proposed air quality analysis for the EIS also includes comparative quantitative hot-spot modeling of CO, PM_{10} , and $PM_{2.5}$.

2.1.1 Criteria Air Pollutants

The following transportation-related CAPs will be included in the emissions inventories: CO, nitrogen dioxide (NO_2), sulfur dioxide (SO_2), PM_{10} , and $PM_{2.5}$, as well as the ozone (O_3) precursors nitrogen oxides (NO_x) and volatile organic compounds (VOCs).

2.1.2 Mobile Source Air Toxics

The emissions inventories will include the nine MSATs identified by EPA to be among the national- and regional-scale cancer risk drivers or contributors and noncancer hazard contributors (EPA 2014) and currently considered as priority MSATs by the Federal Highway Administration (FHWA): 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (DPM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter (POM).

3.0 Analysis Methods

The methodology for the proposed air quality analysis will be conducted in accordance with all applicable state regulations, and it will be based upon guidance from EPA, FHWA, and CDOT. The following relevant guidance will be applied to the methodology for each element of the proposed analysis, where appropriate, as described in this section (**Section 3**) of the work plan and agreed upon by CDOT, FHWA, and EPA:

- Interim Guidance for Project Level Compliance of CRS 43-1-128 (NEPA and Construction) (CDOT 2023a)
- Air Quality Project-Level Analysis Guidance (AQ-PLAG), Version 1 (CDOT 2019)
- Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents (FHWA 2023a)
- Frequently Asked Questions (FAQs): Conducting Quantitative Mobile Source Air Toxics (MSAT) Analysis for FHWA NEPA Documents (FHWA 2023b)
- MOVES4 Technical Guidance: Using MOVES to Prepare Emission Inventories for State Implementation Plans and Transportation Conformity (EPA 2023)
- Guideline for Modeling Carbon Monoxide From Roadway Intersections (EPA 1992)
- Using MOVES3 in Project-Level Carbon Monoxide Analyses (EPA 2021a)³⁷
- Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in PM_{2.5} and PM₁₀ Nonattainment and Maintenance Areas (EPA 2021b)
- NEPA Manual, Version 7 (CDOT 2023b)³⁸

Although quantitative hot-spot analyses for CO, PM₁₀, and PM_{2.5} analysis are not required by state regulations, they will be conducted to comparatively evaluate potential future air quality impacts from the No Action and selected Build Alternatives for the Project.³⁹ This work is in addition to a quantitative comparison of project-level emissions of all pollutants in the analysis (CAPs and MSATs) across existing conditions, the No Action Alternative, and the selected Build Alternatives for the Project.

3.1 Quantitative Emissions Analysis for Comparison of Alternatives

For the proposed quantitative project-level emissions analysis, a lookup table of EFs for all CAPs and MSATs listed in **Section 2.1** will be generated by running the most recent version of EPA's Motor Vehicle Emissions Simulator (MOVES) available when this work plan was prepared (i.e., MOVES4.0.1) for each analysis year and incorporating re-entrained road dust/sanding

³⁷ Note that, when this work plan was developed, EPA had not updated the referenced guidance document to reflect use of MOVES4, the latest version of MOVES released in August 2023 with a subsequent "patch" version (MOVES4.0.1) in January 2024; though the guidance applies as for MOVES3 with exception of an update in MOVES4 for Alternate Vehicle Fuel and Technologies (AVFT) fuels input. The MOVES4 technical guidance (EPA 2023) provides further information regarding the AVFT input.

³⁸ Although the air quality analysis described in this work plan will be conducted to meet state requirements, guidance for federal analyses will inform the approach and methods used.

³⁹ The proposed air quality analysis goes beyond state requirements by including detailed modeling elements to evaluate potential project-level air quality impacts of specific concern to the public, as documented during outreach activities for the Project hosted by CDOT (see CDOT's Public Involvement webpage at <https://www.codot.gov/projects/studies/i270study/public-involvement>, where comments from a Public Scoping Meeting held on October 10, 2023, are listed).

EFs provided by the Colorado Department of Public Health and Environment (CDPHE) Air Pollution Control Division (APCD).⁴⁰ Before its subsequent use in calculating project-level emissions for the analysis, CDOT and FHWA will review the lookup table, along with the underlying MOVES input/output files. EPA will be provided the run specifications (RunSpecs) and input/output databases for the MOVES modeling to review. For each analysis scenario (i.e., Existing Conditions in 2023, No Action Alternative in 2050, and the selected Build Alternatives in 2050), EFs from the lookup table will be combined with link-level travel activity (traffic) and roadway-type data to calculate the link-level emissions, which will be aggregated to the Project level for each pollutant. The methodology details for this process are described below.

3.1.1 MOVES Runs - Overview of Approach

MOVES will be run with the Project Scale setting to estimate running exhaust and crankcase running exhaust emissions for all pollutants, as well as brake wear and tire wear PM₁₀ and PM_{2.5} emissions. The MOVES runs will produce EFs for the lookup table. Data for Links input for MOVES will be developed based on hypothetical link-level traffic and roadway data that will cover the range of actual link-level traffic for all analysis scenarios. Link Source Types input for MOVES will be provided by APCD or CDOT.

Mainline and ramp roadway segments will be modeled as urban restricted roadways. Other nonfreeway roadways (e.g., arterials and collectors) 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 0-75 miles per hour (mph) in 1-mph speed bins.⁴¹ Emission factors will be developed for both passenger (“non-truck”) vehicle and truck vehicle categories, with appropriate mapping of MOVES source types to non-truck and truck categories.

For the proposed analysis, the winter and summer seasons, represented by the months of January and July, respectively, will be modeled using appropriate fuels inputs for each season. This approach allows for modeling of typical “worst-case” wintertime air quality in Denver as well as the peak summertime period when warm-weather conditions can adversely influence air quality.

Emission factors from the lookup table will be applied (outside of MOVES) to Project-specific link-level traffic data in order to calculate link-level emissions, which will be aggregated to the project level for each analysis scenario. The EFs in the lookup table by vehicle type and speed (from the MOVES runs and incorporated road dust/sanding EFs) will be applied to the

⁴⁰ Note that using MOVES to generate a project-scale lookup table of EFs eliminates the need to use project-specific traffic data as part of the MOVES inputs and adds flexibility to the analysis. If traffic data change or new links are later added to the analysis, updated emissions can be calculated without needing to revise MOVES inputs and re-run the MOVES model.

⁴¹ Note that only a single road grade (equal to 0%) will be modeled in MOVES for the quantitative emissions inventory analysis, consistent with normal practices for emissions inventory development using the MOVES model. **Section 3.1** discusses the proposed methodology for a set of comparative inventories of project-level emissions, while **Section 3.4** describes development of link-level emissions for use in the PM hot-spot modeling. Emission inputs for the proposed PM hot-spot modeling will be based on a range of road grades modeled in MOVES. Although the hot-spot modeling in this analysis is not required for regulatory purposes it will be informed by the EPA transportation conformity guidance for quantitative analyses (EPA 2021b).

link-level traffic data to calculate the emissions for each link by traffic time period. The traffic data are anticipated to vary across four time periods during the day (i.e., AM Peak, Midday, PM Peak, and Evening).

3.1.2 MOVES Run Specification Inputs

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

Table 1. MOVES RunSpec options

Navigation Panel	Model Selection
Scale	Project scale; inventory calculation type
Time Spans	Hour; weekdays; January/July; calendar years 2023 and 2050
Geographic Bounds	Adams County
Vehicles	All MOVES4 vehicle and fuel type combinations
Road Types	Urban restricted access, urban unrestricted access
Pollutants and Processes	CAPs and MSATs listed in Section 2.2; running exhaust and crankcase running exhaust (all pollutants), and brake wear and tire wear (only PM ₁₀ and PM _{2.5})
General Output	Units of grams and miles
Output Emissions Detail	Road type

3.1.3 MOVES Project Data Manager Inputs

After the RunSpecs are created, an input database table must be created before running MOVES. This process is done using the Project Data Manager to enter project-specific data. Table 2 summarizes the MOVES Project Data Manager inputs, and these inputs are discussed in more detail below.

Table 2. MOVES Project Data Manager inputs

Project Data Manager Tab	Data Source
Meteorology Data	Provided by APCD
Age Distribution	Provided by APCD
Fuel	MOVES defaults; and AVFT ^a data provided by CDOT
Retrofit	No inputs (not applicable)
Inspection and Maintenance (I/M) Program	Provided by APCD
Link Source Type	Generated by the Air Quality Consultant using traffic count data provided by APCD ^b
Links	Generated by the Air Quality Consultant

^a AVFT = Alternate Vehicle Fuel and Technology

^b Note that the data provided by APCD are based on local Highway Performance Monitoring System (HPMS) traffic counts and reflect a statewide average for urban freeways and are only used to define the vehicle type mix for

separate "car" and "truck" input files for MOVES. The project-specific fleet mix will be represented in the emissions analysis by the Denver Regional Council of Governments (DRCOG) TDM results for "car" and "truck" traffic volumes.

3.2 Meteorology Data

The meteorology data for this analysis will be consistent with those used in the regional emissions analysis for transportation conformity and will be provided by APCD. The relevant data provided by APCD for each modeled season will be used to calculate average temperature and humidity for each traffic time period in the two seasons. Note that MOVES PM running exhaust, brake wear, and tire wear emissions are not affected by meteorological inputs.

3.3 Vehicle Age Distribution

The vehicle age distribution input for the modeling, which will be provided by APCD, is expected to be based on their latest available composite of vehicle registration data from seven Denver area counties (i.e., Adams, Arapaho, Boulder, Broomfield, Denver, Douglas, and Jefferson). These data will be used to represent the age distribution in the analysis years (2023 and 2050).

3.4 Fuel

Consistent with APCD's standard practice, the default parameters in MOVES for fuel inputs will be used with the addition of AVFT data from CDOT to reflect the future zero emission vehicle (ZEV) fleet resulting from the state's adoption of the Colorado Clean Cars and Advanced Clean Trucks rules that can be accommodated in MOVES4.

3.5 Inspection and Maintenance Parameters

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

3.6 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, one for light-duty vehicles and one for heavy-duty trucks, such that two sets of link source type inputs will be needed: one set with fractions for the four types of MOVES light-duty vehicles (MOVES sourcetypes 11, 21, 31, and 32), and one set with fractions for the nine types of heavy-duty vehicles, including buses (MOVES sourcetypes 41, 42, 43, 51, 52, 53, 54, 61, and 62).

For lanes in the Project Build Alternatives included in this analysis that will only permit usage by light-duty vehicles and buses, called Express Lanes, 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:

- Only one Regional Transportation District (RTD) bus route currently uses the corridor, and buses are a very small fraction of total travel.

- The travel activity data provided for this analysis only include traffic volumes for light-duty vehicles and trucks, not separate traffic volumes for buses.
- Including all bus emissions in the truck group will yield a conservative outcome in the proposed quantitative PM hot-spot analyses (described in **Section 3.4**) when those emission sources are located in general-purpose lanes, closer to near-road receptors than they would be if they were located in Express Lanes.

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

3.7 Links

A links input table will be created that represents all possible combinations of road type (urban restricted and unrestricted access) and speed to generate the lookup table of EFs applicable to any traffic link in the analysis scenarios.

3.7.1 Road Dust Emission Factors

The proposed analysis includes re-entrained PM_{10} and $PM_{2.5}$ road dust emissions based on EFs developed and provided by APCD for the Denver region.⁴² These factors were developed based on monitoring studies conducted in 1989 and 1990, and they are applied in State Implementation Plan (SIP) development and regional transportation conformity analyses. They account for both ongoing re-entrained road dust and emissions due, historically, to road sanding (now, deicing) in the winter months. If enforceable commitments for road dust emissions reductions are made as part of the Project Build Alternatives, an alternative set of reduced factors provided by APCD will be used in the analysis. The appropriate set of re-entrained road dust EFs will be added to the lookup table used for calculating PM_{10} and $PM_{2.5}$ emissions for each traffic link and season in this analysis. Since deicing materials are only needed in the winter months, those factors will only be applied to the emissions analysis for the winter season (the month of January); emissions factors for normal re-entrained dust will be applied in the analyses for the winter and summer seasons (the months of January and July).

3.7.2 Calculation of Project-Level Emissions

The project-level emissions for each pollutant and season in all four analysis scenarios will be calculated from the link-level traffic data for each scenario and appropriate EFs from the lookup table developed using MOVES and the road dust EFs provided by APCD. The calculation will be performed as follows. First, the link-level emissions will be calculated for each traffic time period as the product (multiplication) of VMT by all vehicles, number of hours, and

⁴² Although a quantitative project-level analysis of PM_{10} and $PM_{2.5}$ is not required for the Project under state regulations, the proposed analysis includes quantitative PM_{10} and $PM_{2.5}$ emissions and hot-spot analysis. Re-entrained road dust is included in the proposed analysis based on transportation conformity guidance, which discusses the use of road dust EFs from alternative local methods developed for local-specific conditions.

applicable fleet-average total EF based on the fleet mix (i.e., the fraction of passenger and truck vehicles) and average speed in each traffic time period:

$$E_{link}^{TP} = VMT_{link}^{TP} \times hrs \times \left(f_t^{TP} \times EF_t(v^{TP}) + (1 - f_t^{TP}) \times EF_{pass}(v^{TP}) \right) \text{ Equation 1}$$

where

$$E_{link}^{TP} = \text{link - level emissions for a single time period (TP)}$$

$$VMT_{link}^{TP} = L_{link} \times V_{tot}^{TP}$$

$$L_{link} = \text{link length (miles)}$$

$$V_{tot}^{TP} = V_{pass}^{TP} + V_t^{TP} = \text{total vehicle volume in the TP}$$

$$V_{pass}^{TP} = \text{passenger vehicle volume in the TP}$$

$$V_t^{TP} = \text{truck vehicle volume in the TP}$$

$$hrs = \text{number of hours in the TP}$$

$$f_t^{TP} = \frac{V_t^{TP}}{V_{tot}^{TP}} = \text{truck fraction of } V_{tot}^{TP}$$

$EF_t(v^{TP})$ = emission factor for truck vehicles as a function of average speed, v, for the TP (g/mile)

$EF_{pass}(v^{TP})$ = emission factor for passenger vehicles as a function of speed, v, for the TP (g/mile)

Note that the EFs by vehicle type and speed in **Equation 1** represent the sum over the emission processes modeled in MOVES (i.e., running exhaust and crankcase running exhaust for all pollutants, plus brake wear and tire wear for PM₁₀ and PM_{2.5}) as well as the PM road dust EF based on analysis season. For each traffic link, the average speed for each time period and the road type will be used as keys to identify the applicable EFs for passenger and truck vehicles in the lookup table. As the Project traffic volumes represent annual average volumes, CDOT monthly ATR summary data will be used to develop seasonal traffic adjustments.

After the link-level emissions by time period for each link have been calculated, the total link-level emissions will be calculated as the summation of **Equation 1** over all time periods. Finally, the project-level emissions will be calculated by summing the total link-level emission for each link over all links in the traffic data. The project-level emissions inventories for the different categories of pollutants (i.e., CAPs and MSATs) will be reported in appropriate mass units per day.

4.0 Qualitative Analysis of Construction Emissions

As described in **Section 2**, construction for this Project is not expected to last long enough to require quantitative analysis of fugitive dust emissions from construction for transportation conformity. Fugitive dust and other pollutant emissions from construction of the Project will be considered qualitatively. The proposed air quality analysis will include a short discussion of

construction emissions, air quality impacts, and potential avoidance, minimization, and control measures for construction of the Project.

4.1 Carbon Monoxide Hot-Spot Modeling

A comparative quantitative CO hot-spot modeling will be conducted in the proposed analysis for the worst-performing intersection identified in the traffic analysis for the No Action and selected Build Alternatives in the horizon year, 2050. The CAL3QHC model (i.e., version 2.0) will be used to model dispersion of CO emissions from traffic on the intersection links and estimate resulting CO concentrations at appropriately located receptors. The study area(s) for the CO hot-spot modeling will be determined via consultation with CDOT and FHWA. Specification of the geometry of the intersection links (e.g., start/end coordinates of links or lanes as appropriate and lane widths) for CAL3QHC will be based on data provided by the Project design engineers. MOVES4 will be run with the Project Scale setting, largely as described in **Sections 3.1.1 through 3.1.3** to obtain composite running and idling EFs for the base year (2023) to provide as input to CAL3QHC. In contrast to the MOVES methodology described in **Section 3.1**, the approach for the CO hot-spot analysis is to provide Project-specific inputs to the Project Data Manager for the link characteristics (e.g., roadway type and grade) and travel activity (i.e., passenger and truck vehicle volumes, average speeds, and idle times in queue links) for each approach, queue, and departure link at the intersection. Those Project-specific inputs will be provided for the peak hour in the horizon year (2050) by the design and traffic engineers for the Project.

Additional inputs to CAL3QHC for the proposed hot-spot analysis will include a worst-case meteorological condition of 1 meter per second wind speed, a 1,000-meter mixing height, stability class “D,”⁴³ and surface roughness based on land use categories in the area surrounding the worst-performing intersection. Wind directions will be evaluated in 10-degree increments from 0 to 360 degrees. Receptors will be placed near the intersections, with exact locations determined by the features surrounding the intersection and following EPA guidance. Receptor heights will be specified as 1.8 meters above ground level. An appropriate 1-hour CO background concentration value will be provided by APCD for input to the model, and a region-specific persistence factor also provided by APCD will be applied to the resulting maximum modeled 1-hour CO concentration from CAL3QHC to estimate the maximum 8-hour average CO concentration at the intersection.

4.2 Particulate Matter Hot-Spot Modeling

The proposed comparative quantitative PM hot-spot modeling (for PM₁₀ and PM_{2.5}) will be conducted, as described in the following subsections, to assess potential air quality impacts of project-level mobile source PM emissions, especially in minority and low-income communities and at other locations, such as parks, schools, and trailheads, where the public may gather near the I-270 corridor in the vicinity of the Project. The dispersion modeling for the hot-spot analyses will be performed using the most recent version of the American Meteorological Society/Environmental Protection Agency Regulatory Model (AERMOD) when this work plan was prepared (i.e., version 23132). The proposed PM hot-spot modeling will

⁴³ Worst-case meteorological conditions, including urban worst case stability class of “D,” are consistent with EPA’s Guideline for CO hot-spot modeling (EPA, 1992).

provide a summary of the modeled near-road concentrations of PM_{10} and $PM_{2.5}$ due to the link-level emissions from the No Action and selected Build Alternatives in the horizon year, 2050. It will include an assessment of corresponding design concentrations (previously referred to as “design values” in earlier versions of EPA’s PM hot-spot guidance) for the modeled Alternatives. The design concentrations, which will be calculated by adding the appropriate PM_{10} and $PM_{2.5}$ background concentrations provided by APCD to the modeled concentrations at each receptor location in the modeling domain, will be compared across the Alternatives and to the relevant PM_{10} and $PM_{2.5}$ National Ambient Air Quality Standards (NAAQS). AERMOD input and output files will be provided to CDOT, FHWA, and EPA for review.

The study area(s) for the PM hot-spot modeling will be determined via consultation with CDOT, FHWA, and EPA. Receptors will extend to a distance of 300-500 meters from the modeled Project traffic links. Receptors will include the general population, minority and low-income communities, public gathering areas, and additional receptors that have been requested by the public and are beyond 300-500 meters from the Project (see the sensitive receptors listed in **Section 3.4.3**). Although EPA’s PM hot-spot guidance recommends that receptors extend 100 meters from the modeled roadway sources, an expanded modeling domain may better illustrate the typical steep drop-off of near-road concentrations to background concentration levels and will provide broader coverage of communities in the vicinity of the Project. Isopleth contour plots of the resulting design concentrations, as well as tables of modeled concentrations and design concentrations for each pollutant and relevant averaging period, will be prepared. Electronic data files with the modeling inputs and outputs will be provided for interagency review and the administrative record.

4.2.1 Emission Source Layouts

The emission source layouts for the hot-spot modeling will be based on the roadway geometry and lane-striping base map layers for the design of the Alternatives to be analyzed. The complexity and level of refinement needed for the AERMOD source layouts and source input parameters will be determined by the Project design and traffic data, where a greater level of refinement is anticipated where highest concentrations may be expected (e.g., near major interchanges and intersections affected by the Project). EPA’s PM hot-spot guidance, which will inform the modeling in this analysis, 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. The layouts will include lane-level representation of multi-lane traffic links where necessary (e.g., to avoid placement of receptors within volume source exclusion zones) and at intersections with turning-movement lanes and corresponding traffic data.

Because setting up roadway source layouts in AERMOD is time intensive, this part of the work effort will first be completed for traffic links that are not expected to change during completion of (1) the comparative screening of Alternatives, and (2) subsequent selection of Build Alternatives for this detailed analysis. The source layouts can be completed in advance of receiving final traffic data if no changes to the design of the modeled Alternatives will occur. Traffic data from the microsimulation modeling will be used to calculate emission rate inputs for all AERMOD sources to streamline traffic data processing for intersection and free flow traffic links. Before final modeling runs are conducted with the roadway geometry (e.g.,

lane locations, number of lanes, roadway widths) using the design and traffic data from the microsimulation for each of the analysis Alternatives, CDOT and FHWA will review the AERMOD source setups.

4.2.2 Emission Source Input Parameters

Appropriate volume source parameter inputs, following EPA's PM hot-spot guidance, will be calculated based on link geometry and the mix of passenger and truck vehicles (fleet mix) in each traffic link for each time period, as appropriate (see Table 3).

Table 3. 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_{y0}	$w \div 2.15$
Initial vertical dimension (height, H)	1.7 times the weighted average vehicle height for each lane or link ^b
Initial vertical dispersion coefficient, σ_{z0}	$H \div 2.15$
Release height, $Relhgt^c$	$0.5 \times H$

^a Lane width assumed for all lanes except single-lane ramps ($w = 15$ feet) and multi-lane intersections ($w = 11$ feet). These may vary by traffic link and will be specified based on the final project design characteristics provided for the air quality analysis.

^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.

^c Roadway elevation will be added to the release height input for sources representing traffic links/lanes, or portions of those, in areas of the Project where the highest concentrations are anticipated to occur due to travel activity characteristics and roadway geometry. This additional level of detail provides a more realistic representation of the sources but is not a requirement in EPA's hot-spot guidance.

Emission rate inputs for the dispersion modeling will be developed by running MOVES4 using the methodology described in **Section 3.1** for the quantitative comparative emissions analysis, for only PM_{10} and $PM_{2.5}$ pollutants and the 2050 horizon year, and with the following modifications to address a greater level of detail required for the dispersion modeling:

- Road grades will be represented in 1% increments from -6% to +6%
- Each of three "fuel seasons," with appropriate fuels inputs for each, to model the possible combinations of gasoline and diesel fuel sold in the Denver metro area will be included⁴⁴

Note that representation of different months or times of day will not be needed in the MOVES runs for this analysis, because PM running exhaust, brake wear, and tire wear emissions are not affected by temperature or humidity in MOVES.

For the PM hot-spot modeling with AERMOD, emission rate inputs for the volume source representations of the traffic links will be calculated by traffic time period and AERMOD season (mapped from the MOVES-input seasons based on fuel blends) using **Equation 1** in

⁴⁴ Since all fuel seasons will be modeled, the MOVES runs performed for the PM hot-spot modeling will capture the fuel season that would result in the highest PM emissions, as recommended in EPA's PM hot-spot guidance.

Section 3.1.5 (with application of a conversion factor to obtain the emissions in units of grams/second).

4.2.3 Receptor Layouts and Input Parameters

Once CDOT and FHWA conclude their reviews of the source layouts for each analysis scenario, the corresponding receptor network will be defined. A single AERMOD receptor network to be used for all modeled Alternatives will be developed through consultation between CDOT and FHWA to ensure adequate and appropriate coverage of areas where the public gathers (i.e., where people live, work, and play). Development of the receptor network will be informed by EPA's PM hot-spot guidance with an emphasis on such gathering areas, including discrete locations with sensitive populations such as schools, environmental justice/disproportionately impacted communities, and trailheads. A quality assurance (QA)/quality control (QC) process will ensure that no receptors fall within a volume source exclusion zone.

The network of receptors will be located from the right-of-way (ROW) line to 100 meters from the ROW line along the roadways (with receptors no closer than five meters from the edge of roadways), and receptors will be spaced approximately 25 meters apart near residential areas and approximately 50 meters apart near industrial areas. Between 100 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. 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 network of receptors will provide sufficient resolution and coverage to capture maximum concentrations and concentration gradients. Additional discrete receptors will be included at selected sensitive locations outside of the 500-meter buffer zone to capture specific locations identified from public input. A preliminary review of sensitive receptors identified locations that will be evaluated for PM impacts through hot-spot modeling, which include, but are not limited to:

- 14 Stars Early Learning Center
- Adams Heights Residents
- Adams County School District 14
- Alsup Elementary School
- Assumption Catholic School
- C4 Campus
- Central Elementary School
- Kearney Middle School
- Kids First Health Care
- Leyden Park
- Monaco Park
- Northfield Pond Park
- Pioneer Park and Paradise Island Pool
- Rose Hill Elementary School
- Sanville Preschool
- Suncor Boys and Girls Club

- Sunshine Head Start
- Veterans Memorial Park
- Victory Preparatory Academy
- Welby and Other Residents
- Welby Community School
- Wetland Park

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.

4.2.4 Model Options

Use of the flat terrain model option is proposed 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 approach is consistent with EPA's PM hot-spot guidance that the project area should be modeled as having flat terrain in most situations. Urban dispersion in AERMOD will be applied using a population of 3.2 million, which was the approximate population of the metropolitan area of Denver reported by the Metro Denver Economic Development Corporation when this work plan was prepared.⁴⁵ Plume depletion and particle deposition will not be modeled.

4.2.5 Meteorology Inputs

Five years of AERMOD-ready meteorological data will be used in the dispersion modeling based on EPA's guidance for off-site data. The Permit Modeling Unit (PMU) at APCD, which makes recommendations on data to be used for regulatory modeling throughout the state, determined that surface-based meteorological data measured at two different stations are representative for different locations along the I-270 corridor and made the recommendation summarized in Table 4 for which meteorological data sets to use in the dispersion modeling. The recommended surface meteorological data, processed by the PMU with the AERMOD meteorological preprocessor, AERMET (version 23132), for use in AERMOD, were collected at the Ft. St. Vrain and Denver Stapleton International Airport stations.⁴⁶ The proposed analysis includes modeling major interchange areas of the Project separately and using the AERMOD-ready meteorological data files prepared by the PMU with the ADJ_U* option enabled.⁴⁷

⁴⁵ The Metro Denver population was obtained at <https://www.metrodenver.org/regional-data/demographics/population>.

⁴⁶ The Ft. St. Vrain station was at 104.872° W 40.254° N, about 30 miles north of the Project at 1,455.7 meters elevation above mean sea level (MSL). The Denver Stapleton International Airport station refers to the previous site of Denver's main airport, which was located near the I-270/I-70 interchange at 104.867° W 39.767° N and 1,611.0 meters elevation above MSL.

⁴⁷ 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.

Table 4. Summary of meteorological data representativeness for the Project

Corridor Location (Identified by Interchange)	Recommended Meteorological Station
I-270/I-25	Ft. St. Vrain
I-270/I-76	Ft. St. Vrain
I-270/York	Ft. St. Vrain
I-270/Vasquez	Ft. St. Vrain
I-270/Quebec	Ft. St. Vrain
I-270/I-70	Denver-Stapleton
I-270/I-25	Denver-Stapleton

4.2.6 Background Concentrations

The latest available representative background concentrations for PM_{10} and $PM_{2.5}$ will also be provided by APCD, which last conducted an analysis of background concentration data for the Project area in June 2023. That analysis used the three most recent complete annual sets of data from monitors in the Project area that were available in the EPA Air Quality System (AQS) at the time. The monitoring data used in their calculations for the Commerce City monitoring site (AQS site ID 08-001-0008), the site determined most representative, are from the years 2018, 2019, and 2022.⁴⁸ $PM_{2.5}$ measured concentrations for 2018 and 2022 were adjusted in APCD's analysis by removing data on dates when the particulate samplers were believed to have been affected by wildfire smoke. APCD did not adjust measured concentrations of PM_{10} used in the background estimate because days with the highest concentrations of PM_{10} did not coincide with days determined to be impacted by wildfire smoke or blowing dust. The representative background concentrations that APCD calculated following EPA guidance for exclusion of measured concentration data (EPA 2019) in June 2023 are:

- PM_{10} (24-hour): $104 \mu\text{g}/\text{m}^3$
- $PM_{2.5}$ (24-hour): $21 \mu\text{g}/\text{m}^3$ (including the adjustment for wildfire days)
- $PM_{2.5}$ (Annual mean): $8.6 \mu\text{g}/\text{m}^3$ (including the adjustment for wildfire days)

With concurrence from EPA Region 8 on the approach used by APCD to estimate the representative background concentrations, those values will be used in calculating design concentrations for the PM hot-spot modeling.⁴⁹

4.2.7 Design Concentrations

Design concentrations for 24-hour average PM_{10} and $PM_{2.5}$ and for annual average $PM_{2.5}$ will be calculated according to methods in EPA's PM hot-spot guidance. For these pollutant and averaging periods, the design concentrations for the modeled Alternatives will be compared with each other and the relevant NAAQS. If necessary, design concentrations for 24-hour

⁴⁸ Data from the years 2020 and 2021 were excluded from the background concentration analysis due to roof construction at the monitoring location.

⁴⁹ If a complete set of monitoring data for 2023 are available for APCD to update their analysis and provide new background values when the analysis is conducted, those will be used in place of the data provided in June 2023.

average PM_{2.5} will be recalculated using the less-conservative Tier 2 approach described in EPA's PM hot-spot guidance.

5.0 Reporting

After completion of the proposed air quality analysis described in this work plan, an air quality technical report for the EIS will be prepared to document the results, along with the analysis methodology, input data, and key assumptions used for each element of the analysis. This report will include a discussion of the relevant regulations, air pollutants, and air quality concerns, as well as potential avoidance, minimization, and control strategies. Some aspects of the report, such as any control strategy commitments for the Project, will require contributions from CDOT or other consultants for the EIS.

6.0 References

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Appendix B. Amendments to the Air Quality Analysis Work Plan

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The Air Quality Analysis Work Plan (**Appendix A**), approved July 11, 2024, documented the methodology details for the air quality analysis. Some changes to the Work Plan were made as the analysis unfolded. The changes and justifications were discussed and approved in Air Quality Working Group meetings and documented in the administrative record for the Project.

Amendments to the Air Quality Analysis Work Plan are described below.

- **Resuspended PM Road Dust.** Resuspended PM_{2.5} road dust was not modeled in the quantitative emissions analysis and comparative quantitative PM hot-spot analysis because the Project area is in attainment for the PM_{2.5} NAAQS and neither APCD nor EPA have made a finding that road dust is a significant contributor to PM_{2.5} concentrations in the region. Furthermore, all PM_{2.5} monitors within the state of Colorado are expected to be in attainment with the newly established 2024 NAAQS for PM_{2.5}. The analyses retain consideration of resuspended PM₁₀ road dust, as PM₁₀ road dust is a significant contributor to PM₁₀ concentrations in the region.
- **Meteorological Data.** Meteorological data from the Fort St. Vrain station was not used in the comparative quantitative PM hot-spot analysis as only one year of data was available from that station, which is not site-specific. Five years of meteorological data are recommended for PM hot-spot analyses in EPA's PM hot-spot analysis modeling guidance (EPA 2021b) and in 40 CFR Part 51, Subpart W Guideline on Air Quality Models, Section 8.4.2(e). The quantitative comparative PM hot-spot analysis used five years of representative meteorological data from the Denver Stapleton International Airport station for the entire Project study area.
- **Receptor Grid (24-Hour PM_{2.5} and PM₁₀ Modeling).** AERMOD receptors were added to the analysis for commercial parcels from the ROW line to 100 m from the roadway at approximately 25 m spacing. Commercial parcels were not mentioned in the Work Plan. Receptors were also added to the analysis along sidewalks and trails adjacent to the roadways based on the Questions and Answers: Hot-spot Analyses and Project-Level Conformity Determinations published by EPA in August 2024 (EPA 2024). Aside from these additions, the analysis included receptors from the ROW line along the roadway (with receptors no closer than five meters from the edge of roadways) to 100 m from the

roadway for residential areas (at approximately 25 m spacing) and industrial areas (at approximately 50 m spacing), per the Work Plan.

- Receptor Grid (Annual $PM_{2.5}$ Modeling). FHWA advised that an alternative AERMOD receptor network was appropriate and justified for annual $PM_{2.5}$ modeling. The receptors for annual $PM_{2.5}$ modeling focused on residential areas and sensitive locations (e.g., schools and hospitals) where it would be appropriate to compare modeled design concentrations to the annual $PM_{2.5}$ NAAQS. The annual $PM_{2.5}$ NAAQS is monitored at “area-wide” locations, including locations with populations living near major roadways. It would not be appropriate to model annual $PM_{2.5}$ concentrations at unique micro-scale locations, such as sidewalks and pedestrian overcrossings, that do not represent area-wide air quality for annual $PM_{2.5}$ NAAQS compliance purposes.
- Project Limits (Determination of Non-Project Links). FHWA advised using an amended approach for determining which non-project links are impacted by the Project, particularly because several intersections that are not part of the Project connect with Project roadways. The amended approach used only distance from the Project (100 m) and AADT to evaluate whether non-project links would be impacted by the Project. FHWA advised against considering other travel activity parameters such as travel speed and delay. This resulted in a more consistent and streamlined approach for determining the non-project links to include in the air quality analysis.
- Project Limits (Vasquez/60th/Parkway). The intersection at Vasquez Blvd./60th Ave./Parkway Dr. was not included in the quantitative emissions analysis or the comparative quantitative PM hot-spot analysis. This intersection fell outside the 100 m project buffer, and traffic modeling data for this intersection was not sufficiently detailed for refined PM hot-spot modeling because the intersection was near the boundary of the traffic modeling analysis for the Project.

Appendix C. Emissions Analysis Methods

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This appendix describes the approach for modeling operational emissions from motor vehicles using the Mobile Source Vehicle Emissions Simulator (MOVES) model and development of the quantitative emissions inventory for the Project. This process involves setting up a run specification for the MOVES model, entering project data using a MOVES tool called the Project Data Manager, running MOVES, exporting the results as an emissions lookup table, and then using project traffic data combined with the lookup table to calculate project operating emissions for each year and project alternative. These steps are described in more detail below.

1.0 Traffic Data

As described in the Traffic Technical Report in the I-270 Corridor Improvements Environmental Impact Statement, the project team selected the Denver Regional Council of Governments (DRCOG) Focus version 2.3.2 Travel Demand Model and TransModeler 6.1 microsimulation software as the primary tools for the I-270 traffic analysis. These tools provide accurate traffic forecasts and detailed simulations and meet the technical requirements established by the Colorado Department of Transportation (CDOT) and the Federal Highway Administration (FHWA). The analysis uses the 2023 base year and 2050 horizon year travel demand models from Focus version 2.3.2 for the existing and future traffic condition analyses.

The emissions inventories were developed using lookup tables of emissions rates by vehicle type, road type, and speed (described below), and estimates of vehicle miles traveled (VMT) and speeds by vehicle type from the traffic data. The traffic data provide estimates of traffic volume and speed for each modeled roadway segment (link); the traffic volume was combined with the length of each link in miles to estimate VMT. These calculations were performed separately for cars and trucks, as data for these two vehicle types are included in the summary traffic data.

The emissions inventory includes all roadway links involved in the project, as well as adjacent roadway links where traffic is affected by the project (see Figure 2 in Section 6.1 in the main body of this Air Quality Technical Report). These “non-project” links were identified using the criteria contained in FHWA’s *Mobile Source Air Toxics Frequently Asked Questions*,⁵⁰ which

⁵⁰ Frequently Asked Questions (FAQs): FHWA Recommendations for Conducting Quantitative Mobile Source Air Toxics (MSAT) Analysis for FHWA NEPA Documents,

provide the only available recommendations for identifying links affected by a highway project. These criteria are:

1. a 5 percent or more change in annual average daily traffic (AADT) on congested highway links of level of service (LOS) D or worse;
2. a 10 percent or more change in AADT on uncongested highway links of LOS C or better;
3. a 10 percent or more change in travel time; or
4. a 10 percent or more change in intersection delay.

These criteria were applied to all modeled roadway links to arrive at a final set of project and non-project links to include in the emissions inventory analysis.

Note that because the DRCOG travel demand model and the Traffic Technical Report findings are based on different modeling approaches (travel demand modeling versus microsimulation modeling) and slightly different roadway networks (the Traffic Technical Report includes the entire project area, while the emissions analysis includes specific links selected using the criteria above), the two analyses reach different conclusions regarding the changes in VMT under the project alternatives. The analysis documented in this report relies on the DRCOG travel demand model results for the identified emissions analysis network, which project higher VMT for the No Action and 3GPL alternatives, and slightly lower VMT for the 2GPL+1EL Alternative relative to the values in the traffic report.

2.0 MOVES Runs - Overview of Approach

MOVES was run with the Project Scale setting to estimate running exhaust and crankcase running exhaust emissions for all pollutants. The MOVES runs produce emission factors for a lookup table, with emissions by road type, speed, and vehicle type (car or truck). Data for Links input for MOVES were developed based on hypothetical link-level traffic and roadway data that cover the range of actual link-level traffic for all analysis scenarios, as described below. Link Source Type inputs for MOVES, which describe the mix of vehicle types on each link, were developed using data provided by the Colorado Air Pollution Control Division (APCD).

Mainline and ramp roadway segments were modeled as urban restricted roadways. Other non-freeway roadways (i.e., arterials and collectors) were modeled as urban unrestricted roadways. Only on-road links were modeled; no “off-network” links were modeled. “Off-network” links reflect parking facilities, such as park-and-ride lots or truck stops, and no facilities of this type are affected by the project. For each of the two road types, a series of hypothetical links with a traffic volume of one vehicle per hour traveling one mile were created, with average vehicle speed ranging from 0 to 75 miles per hour (mph) in 1 mph speed bins.⁵¹ Emission factors were developed for both passenger (“non-truck”) vehicle and truck vehicle categories, with appropriate mapping of MOVES source types to non-truck and truck categories.

https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/fhwa_nepa_msat_faq_moves3_.pdf

⁵¹ Note that only a single road grade (equal to 0 percent) was modeled in MOVES for the quantitative emissions inventory analysis, consistent with normal practices for emissions inventory development using the MOVES model.

Modeling was performed for a 2023 base year and a 2050 project design year. For the analysis, the winter and summer seasons, represented by the months of January and July, respectively, were modeled using appropriate fuels inputs for each season. This approach allows the modeling to capture wintertime conditions in Denver as well as the peak summertime period when warm-weather conditions impact vehicle air conditioning use.

Emission factors from the lookup table were applied (outside of MOVES) to project-specific link-level traffic data in order to calculate link-level emissions, which were aggregated to the project level for each analysis scenario. The emission factors in the lookup table by vehicle type and speed (from the MOVES runs) were applied to the link-level traffic data to calculate the emissions for each link by traffic time period. The traffic data vary across three time periods during the day (AM Peak, PM Peak, and Evening).

2.1 Run Specification Inputs

MOVES run specifications (RunSpecs) were created to specify the parameter options for the MOVES model. Table 1 summarizes the MOVES inputs for the RunSpecs, as defined in the navigation panel of the MOVES interface.

Table 1. MOVES Run Specification Selections

Navigation Panel	Model Selection
Scale	Project scale; inventory calculation type
Time Spans	Hour; weekdays; January/July; calendar years 2023 and 2050
Geographic Bounds	Adams County
Vehicles	All MOVES4 vehicle and fuel type combinations
Road Types	Urban restricted access, urban unrestricted access
Pollutants and Processes	Running exhaust and crankcase running exhaust (all pollutants)
General Output	Units of grams and miles
Output Emissions Detail	Road type

2.2 Project Data Manager Inputs

After the RunSpecs were created, an input database table for each run was created before running MOVES. This was done using the MOVES 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.

Table 2. MOVES Project Data Manager Inputs

Project Data Manager Tab	Data Source
Meteorology Data	Provided by APCD
Age Distribution	Provided by APCD
Fuel	MOVES defaults; and AVFT ^a data provided by CDOT
Retrofit	No inputs (not applicable)
Inspection and Maintenance (I/M) Program	Provided by APCD
Link Source Type	Generated using traffic count data provided by APCD ^b
Links	Generic links designed to produce an emissions lookup table

^a AVFT = Alternate Vehicle Fuel and Technology

^b Note that the data provided by APCD are based on local Highway Performance Monitoring System (HPMS) traffic counts and reflect a statewide average for urban freeways, and are only used to define the vehicle type mix for separate "car" and "truck" input files for MOVES. The project-specific fleet mix was represented in the emissions analysis by the DRCOG TDM results for "car" and "truck" traffic volumes.

2.2.1 Meteorology Data

The meteorology data for this analysis were consistent with those used in the regional emissions analysis for transportation conformity and were provided by APCD. The relevant data provided by APCD for each modeled season were used to calculate average temperature and humidity for each traffic time period in the two seasons.

2.2.2 Vehicle Age Distribution

The vehicle age distribution input for the modeling, provided by APCD, is based on their latest available composite of vehicle registration data from seven Denver area counties (Adams, Arapaho, Boulder, Broomfield, Denver, Douglas, and Jefferson). These data were used to represent the age distribution in the analysis years (2023 and 2050).

2.2.3 Fuel

Consistent with APCD's standard practice, the default parameters in MOVES for fuel inputs were used, with the addition of AVFT data from CDOT to reflect the future zero emission vehicle (ZEV) fleet resulting from the state's adoption of the Colorado Clean Cars and Advanced Clean Trucks rules. The AVFT inputs define vehicle sales by fuel type and vehicle type in each past and future model year, and the CDOT-provided file reflects implementation of these Colorado rules.

2.2.4 Inspection and Maintenance Parameters

Existing and anticipated future vehicle inspection and maintenance (I/M) program parameters for the Denver metropolitan area were provided by APCD.

2.2.5 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 were conducted, one for light-duty vehicles and one for (heavy-duty) trucks, such that two sets of link source type inputs were needed: one set with fractions for the four types of MOVES light-duty vehicles (MOVES sourcetypes 11, 21, 31, and 32), and one set with fractions for the nine types of heavy-duty vehicles, including buses (MOVES sourcetypes 41, 42, 43, 51, 52, 53, 54, 61, and 62).

For the Express Lanes in the Project Build Alternatives 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, this analysis included buses in the “truck” group, and did not model emissions for any buses in the Express Lanes for two reasons:

- Only one Regional Transportation District (RTD) bus route currently uses the corridor, and buses are a very small fraction of total travel.
- The travel activity data provided for this analysis only include traffic volumes for light-duty vehicles and trucks, and not separate traffic volumes for buses.

Automated Traffic Recorder (ATR) data by vehicle class for representative freeway and arterial segments, provided by APCD, was used, along with MOVES default estimates by VMT by source type, to develop link source type inputs for the two groups of vehicles.

2.2.6 Links

A links input table was created that represents all possible combinations of road type (urban restricted and unrestricted access) and speed to generate the lookup table of emission factors applicable to any traffic link in the analysis scenarios.

2.3 Road Dust Emission Factors

PM road dust emission factors are not modeled by MOVES. APCD provided the road dust emissions factors that are used for the PM_{10} emissions inventories. PM_{10} emissions factors were provided for freeways and arterial roadways, and for normal year-road dust, as well as an incremental “sanding” factor that applies during the winter months (November through March). These factors are listed in Table 3. $PM_{2.5}$ road dust was not modeled because the Denver area is in attainment of the $PM_{2.5}$ NAAQS and neither APCD nor EPA have made a finding that road dust is a significant contributor to $PM_{2.5}$ concentrations.

Table 3. Road Dust Emissions Factors

Pollutant	Road Type	Road Dust Factor, g/mile	Sanding Factor, g/mile
PM_{10}	Freeway	0.1678	0.0513
PM_{10}	Arterial	0.3543	0.0550

Appendix D. CO Hot-Spot Analysis Methods

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1.0 Overview

Although the Project is not subject to conformity requirements for CO, a comparative screening-level quantitative CO hot-spot analysis was conducted to inform the public of potential air quality impacts of the Project alternatives and evaluate whether the Project would result in localized increases in CO concentrations at congested intersections that would violate the NAAQS. The analysis was conducted for the worst-performing signalized intersection identified in the traffic analysis for the No Action, 2GPL+1EL Build, and 3GPL Build Alternatives in the horizon year, 2050. The intersection selected for the CO hot-spot modeling was determined by reviewing traffic modeling results for total volumes and delays during morning (AM) and afternoon (PM) peak hours in the three Project alternatives. Based on that review, the Air Quality Working Group identified the Vasquez Boulevard and East 56th Avenue intersection as the worst-performing because it had the highest modeled traffic volume and delay during peak hours in both Project build alternatives.⁵²

The CO hot-spot analysis was performed in accordance with CDOT's AQ-PLAG (CDOT 2019), the EPA Guideline for Modeling Carbon Monoxide from Roadway Intersections (EPA 1992), and EPA User's Guide to CAL3QHC Version 2.0 (EPA 1995). The EPA CAL3QHC model (version 2.0) was used to model dispersion of CO emissions from traffic on the intersection links and estimate resulting CO concentrations at appropriately located receptors. This modeling is considered to be a screening analysis that yields conservative estimates of modeled CO impacts based on worst-case meteorology with peak hour traffic volumes, peak delays, and 1-8-hour persistence factors. The CO emissions modeling conducted to yield emission rate inputs for CAL3QHC followed the guidance in *Using MOVES3 in Project-Level Carbon Monoxide Analyses* (EPA 2021d). However, the Motor Vehicle Emissions Simulator model MOVES4 was used instead of MOVES3 because the newer version provides more up-to-date default parameters. Per the AQ-PLAG (CDOT 2019), CO hot-spot screening modeling was conducted based on present-day (2023) motor vehicle emission factors (EFs) and future (2050) peak-hour traffic volumes to represent a worst-case emissions scenario. A 1-hour CO background

⁵² Per communication with engineers who conducted the traffic modeling, the highest traffic volume = total volume entering the intersection across all MicroStation model runs for the AM peak hour and the PM peak hour; and the highest traffic delay = traffic volume × delay/vehicle for all MicroStation model runs for the AM peak hour and the PM peak hour.

concentration and a regionally specific persistence factor provided by the Colorado Department of Public Health and Environment (CDPHE) were used with the model results to determine whether the screening analysis predicts localized increases in CO concentrations that would violate the NAAQS.

2.0 Methods

CO emissions for the hot-spot analysis were modeled using EFs from EPA’s MOVES4 model and region-specific inputs. CO EFs were obtained for both free-flow speeds and idling queue links for the base year of 2023 for both AM and PM peak hours. To model EFs, a weighted average fleet mix was calculated using the traffic demand model (TDM) data to weight car and truck distributions and then apply the calculated truck fractions. Winter season CO EFs were used, as they were found to be higher than summer season CO EFs. Free-flow speeds were obtained from the microsimulation modeling conducted by FHU. A speed of 0 mph was used to calculate an idle EF. The motor vehicle EFs of the base year (2023) 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 2019). Both AM and PM peak hours were modeled for the No Action, 2GPL+1EL build alternative, and 3GPL build alternative because the highest volumes and worst-case delays were mixed between AM and PM times. Other inputs used in the CAL3QHC modeling, as described below, are summarized in Table 1.

Table 1. CAL3QHC Modeling Parameters

Input Parameter	Value ^a
Surface Roughness	127 cm
Wind Speed	1 m/s
Stability Class	D
Mixing Height	1,000 m
Wind Direction Increment	10 degrees
Receptor Height	1.8 m
Source Height	Flat (0 m)
Signal Type	Actuated
Intersection Arrival Rate	Average progression

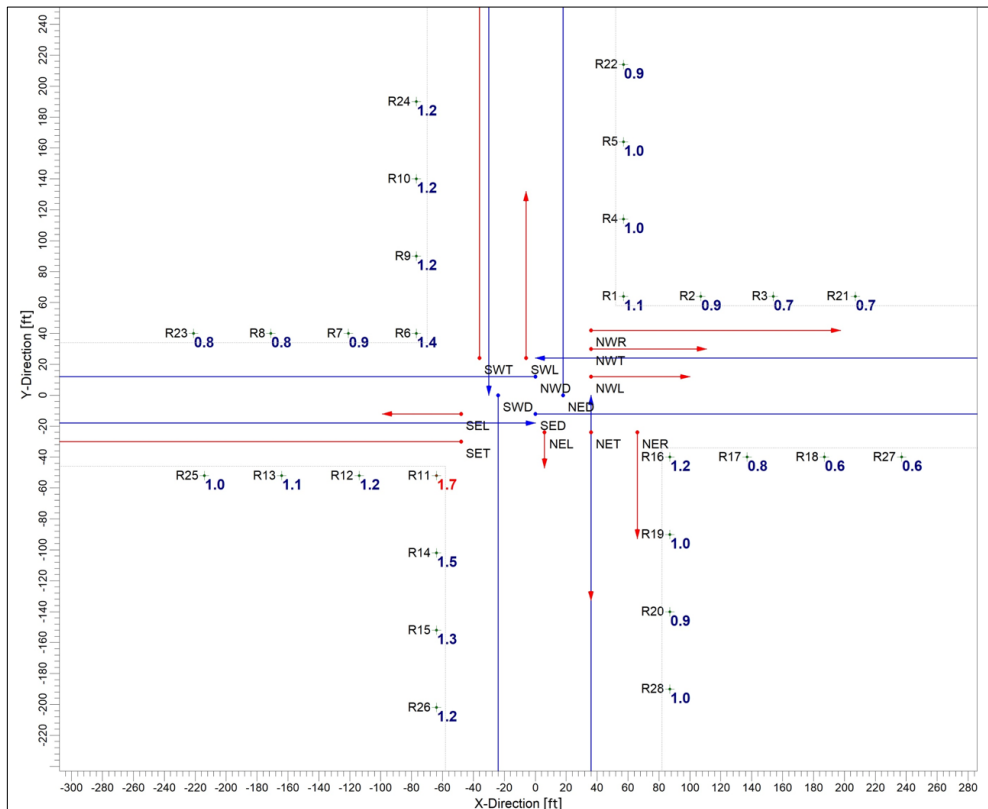
^a Parameter values from EPA 1992 and EPA 1995.

Regulatory values were used for the other CAL3QHC model inputs, including a 1 meter per second wind speed, 10-degree wind direction increments in each cardinal direction from 0 to 360 degrees, a 1,000-meter mixing height, and a stability class “D” (EPA 1992). The surface roughness was based on the land use surrounding the modeled intersection. Land uses in this area are primarily recreational (e.g., the Sand Creek Greenway), along with several low-rise industrial buildings. A surface roughness of 127 centimeters, which represents the roughness of parks, was used for the analysis.

Receptors were placed around the intersection approach links, as maximum concentrations occur where vehicles are slowed or idling at traffic signals, and where free-flow traffic

volumes and emission rates are highest. Specifically, receptors were placed at distances of 0, 15, 30, and 46 meters (0, 50, 100, and 150 feet) along each intersection approach to show the sharp modeled impact gradient along the length of the queuing links and to capture the worst-case impacts at the corners of the intersection (Figure 1). The receptors were placed at the edge of the roadway while accounting for the 3-meter buffer where vehicle turbulence does not allow the model to make valid concentration estimates (EPA 1992), and a regulatory-based receptor height of 1.8 meters (5.9 feet) above ground level was specified.

Figure 1. CAL3QHC Modeling setup showing links (blue: Free-Flow links, red: Queue links), receptors (R1 to R27), and CO 1-hour impacts (ppm) for the worst-case scenario: 3GPL AM peak. The maximum project impact is 1.7 ppm, without background.



The CAL3QHC model results are maximum 1-hour CO concentrations in parts per million, to which the 1-hour background CO concentration of 4.976 ppm, provided by CDPHE,⁵³ can be added for comparison with the 1-hour CO NAAQS. Eight-hour CO concentrations were obtained for comparison with the 8-hour CO NAAQS by multiplying the sum of the maximum 1-hour CO concentration and the background concentration by the regionally specific persistence factor of 0.649, provided by CDPHE. Persistence factors account for the fact that over 8 hours, vehicle volumes would decrease from the peak hour, vehicle speeds may vary, and meteorological conditions, including wind speed and wind direction, would vary compared with assumptions used for the peak hour.

⁵³ The 1-hour CO background concentration provided by CDPHE was the maximum CO concentration monitored in 2023 for the study area.

3.0 Summary of Analysis Results

The CO hot-spot modeling revealed that the peak hour (AM or PM) with the highest volume resulted in the maximum modeled concentration for each Project alternative, despite differences between peak AM and PM traffic delays. The maximum CO concentrations listed in Tables 2 and 3 are well below the applicable NAAQS limits of 35 ppm (1-hour) and 9 ppm (8-hour) under the worst-case traffic and meteorological conditions that were analyzed. All other intersections within the study area would have lower modeled CO concentrations than the worst-performing intersection in this analysis. Therefore, the results demonstrate that the Project would not cause or contribute to violations of the CO NAAQS in the Project study area.

Table 2. Maximum Modeled + Background 1-Hour CO Concentration (ppm) for the Worst-Performing Intersection in 2050 (1-Hr CO NAAQS = 35 ppm)^a

	AM Peak Hour	PM Peak Hour
No Action	5.78 (R11)	5.98 (R1)
3GPL	6.68 (R11)	5.98 (R6)
2GPL+1EL	6.38 (R15)	5.88 (R6)

^a 1-hour results include the 2023 maximum 1-hour background concentration of 4.976 ppm, obtained from CDPHE (CDPHE, 2024).

Table 3. Maximum Modeled + Background 8-Hour CO Concentration (ppm) for the Worst-Performing Intersection in 2050 (8-Hr CO NAAQS = 9 ppm)^b

	AM Peak Hour	PM Peak Hour
No Action	3.75 (R11)	3.88 (R1)
3GPL	4.33 (R11)	3.88 (R6)
2GPL+1EL	4.14 (R15)	3.81 (R6)

^b The regionally specific persistence factor of 0.649, provided by CDPHE, was used to calculate 8-hour CO concentrations (CDPHE 2024).

4.0 References

Colorado Department of Public Health and Environment (CDPHE). 2024. Email communication between Dale Wells of CDPHE, Nancy Chick of CDPHE, and Garnet Erdakos of Sonoma Technology, I-270 2023 Ambient Carbon Monoxide Background Values and Persistence Factor, June 25, 2024.

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>.

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<https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=2000F7L2.pdf>.

Appendix E. PM Hot-Spot Modeling Methods

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This appendix describes some of the methods used in the PM hot-spot modeling in more detail than provided in the Work Plan (Appendix A) and Work Plan amendments (Appendix B). The details described here focus on the emission source layouts, receptor networks, and calculation of design concentrations.

1.0 Characterization of Emission Sources

A series of adjacent volume sources were defined to model on-road vehicle emissions in AERMOD for each traffic link. The coordinates, width, and length of each series was guided by the engineering design of the Project alternatives and simulated traffic data for the horizon year (2050). The georeferenced design data included linework for the traffic lanes on all modeled roadways, sidewalks, and trails in the No Action and Project build alternatives, as well as the pedestrian bridge over I-270 east of the Vasquez Boulevard interchange in the build alternatives. The design data also included linework for existing CDOT projects (e.g., on I-76 at the interchange with I-270) used in the development of emission source layouts in all three Project alternatives.

Coordinates of the AERMOD volume sources were defined to coincide with the centerline of one or more travel lanes in each modeled traffic link. Whether the sources represented more than one lane in a traffic link depended on the required placement of AERMOD receptors. Because model receptors cannot be located within AERMOD volume sources or their “exclusion zones,” which represent the initial horizontal dispersion of emissions due to vehicle-induced turbulence, the horizontal dimension of the volume sources used in this modeling could not span multiple traffic lanes in locations where receptors were required as close or closer than 5 meters from the edge of a traffic lane (e.g., on adjacent sidewalks and trails). In these locations, volume sources were defined to represent individual lanes. In addition to meeting requirements for receptor placement, volume sources were also defined to represent individual lane movements at intersections for which travel data from microsimulation traffic modeling (i.e., traffic volumes for lane movements, approach and departure speeds, and delay time for queued vehicles) were available.

The number of adjacent volume sources representing each modeled traffic link was defined to sufficiently span the length of the link. Link lengths were either (1) provided in the travel activity data developed for the Project or (2) calculated from the travel activity data. TDM-

based travel activity data included link lengths for free-flow links on the I-270 mainline (GPLs and ELs), on- and off-ramps, Quebec St., Vasquez Blvd., Sandcreek Dr., East 56th Ave., and York St. For intersections, link (or lane) lengths were calculated from microsimulation-based traffic data and signal-timing data. The calculations were based on standard assumptions and equations for queueing and acceleration at intersections, as well as recommendations from the Project traffic engineers. These are documented in the administrative record for the Project.

2.0 Development of Receptor Networks

The development of receptor networks for the PM modeling was consistent with the methods described in the Work Plan (Appendix A) and Work Plan amendments (Appendix B). Additional details about the development of receptor networks for the PM modeling are described here because they include recent recommendations for PM hot-spot analyses, and an alternative receptor network was used for modeling annual $PM_{2.5}$ concentrations.

Recommendations from EPA in *Questions and Answers: Hot-spot Analyses and Project-Level Conformity Determinations*⁵⁴ clarified that receptors in PM hot-spot analyses should be placed on sidewalks and other facilities that are intended to provide public access, even when those are closer than 5 meters from the edge of a traffic lane or within a right-of-way. This includes such facilities that are part of a project or affected by the project. The I-270 Corridor Improvements Project includes the addition of sidewalks, multi-use paths, and a pedestrian and bicycle overpass, and there are existing sidewalks and trails adjacent to the modeled roadways. Receptors were included in the PM modeling analysis along all these facilities per the recommendations from EPA. The georeferenced design data provided for the modeling and other geospatial datasets for existing and planned trails were used to guide the specification of receptor coordinates.

The placement of receptors on sidewalks and trails adjacent to modeled roadways would have resulted in localized PM hot-spots that would not be representative of area-wide air quality and, therefore, not eligible for comparison to the annual $PM_{2.5}$ NAAQS, as discussed in the *Transportation Conformity Guidance for Quantitative Hot-Spot Analyses in $PM_{2.5}$ and PM_{10} Nonattainment and Maintenance Areas*.⁵⁵ After discussion with the Air Quality Working Group, FHWA advised that an alternative AERMOD receptor network was appropriate and justified for modeling annual $PM_{2.5}$ concentrations. The alternative receptor network focused on locations where people typically spend the majority of their time. Specifically, receptors were placed in residential areas, schools, hospitals, and churches (no eldercare facilities were identified within 500 meters of the modeled roadways, and the childcare facilities identified were classified as schools based on their educational focus). The sensitive receptors that were identified from public input (see Appendix A) were also modeled in the alternative receptor network. Those are explicitly mentioned here because some of them are located outside the 500-meter boundary defined for the modeling and include parks.

The receptor networks used for the PM modeling based on the methods described here are illustrated below in Figures 1 and 2.

⁵⁴ The guidance is available at <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P101BLJT.pdf>.

⁵⁵ Area-wide air quality corresponds with the definition of annual $PM_{2.5}$ health standards and location of monitoring sites that are eligible for comparison to the annual $PM_{2.5}$ NAAQS. See <https://nepis.epa.gov/Exe/ZyPDF.cgi?Dockey=P1013C6A.pdf>.

Figure 1. Map of the Receptor Network Used to Model 24-hr Average PM_{10} and $PM_{2.5}$.

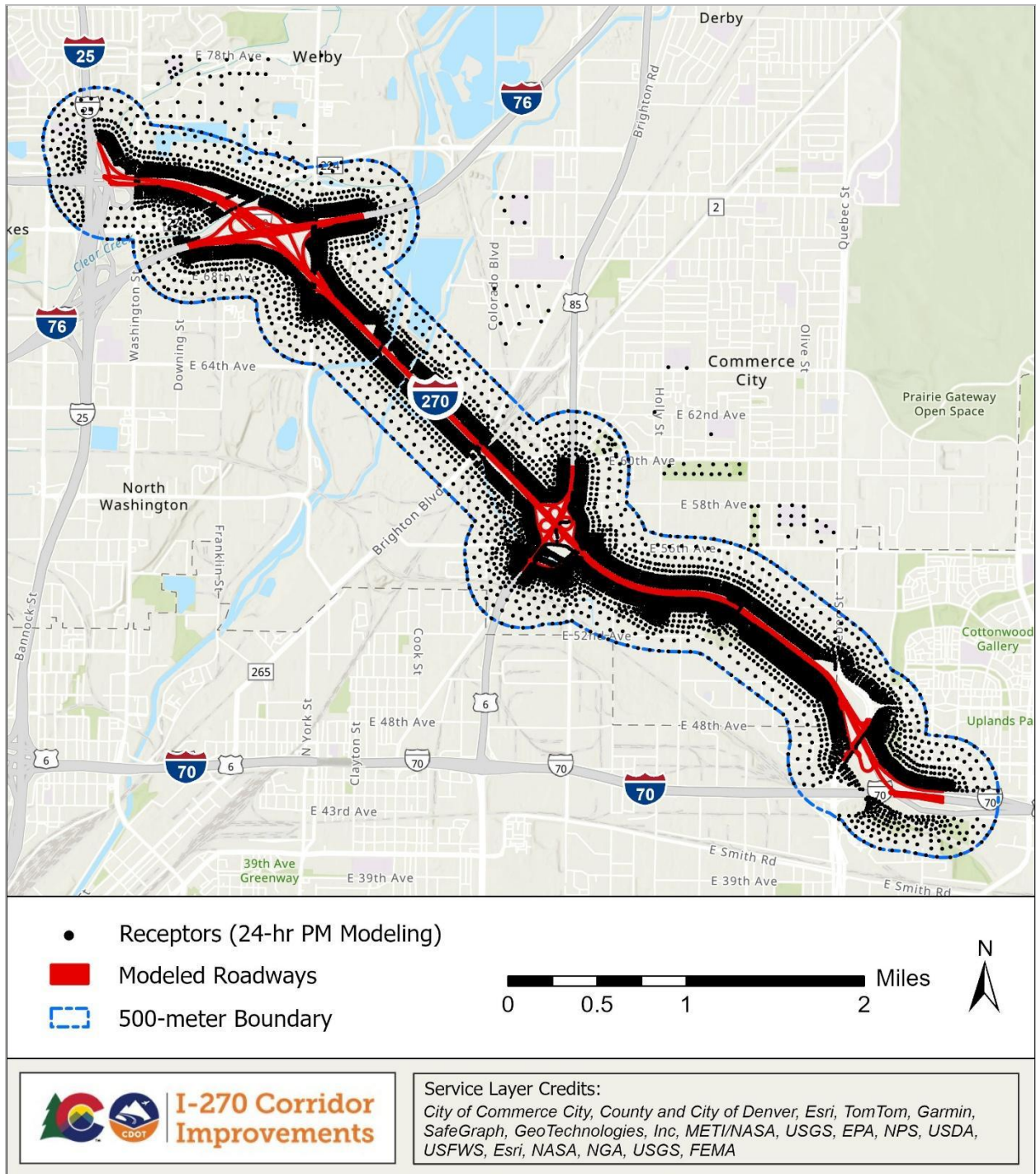
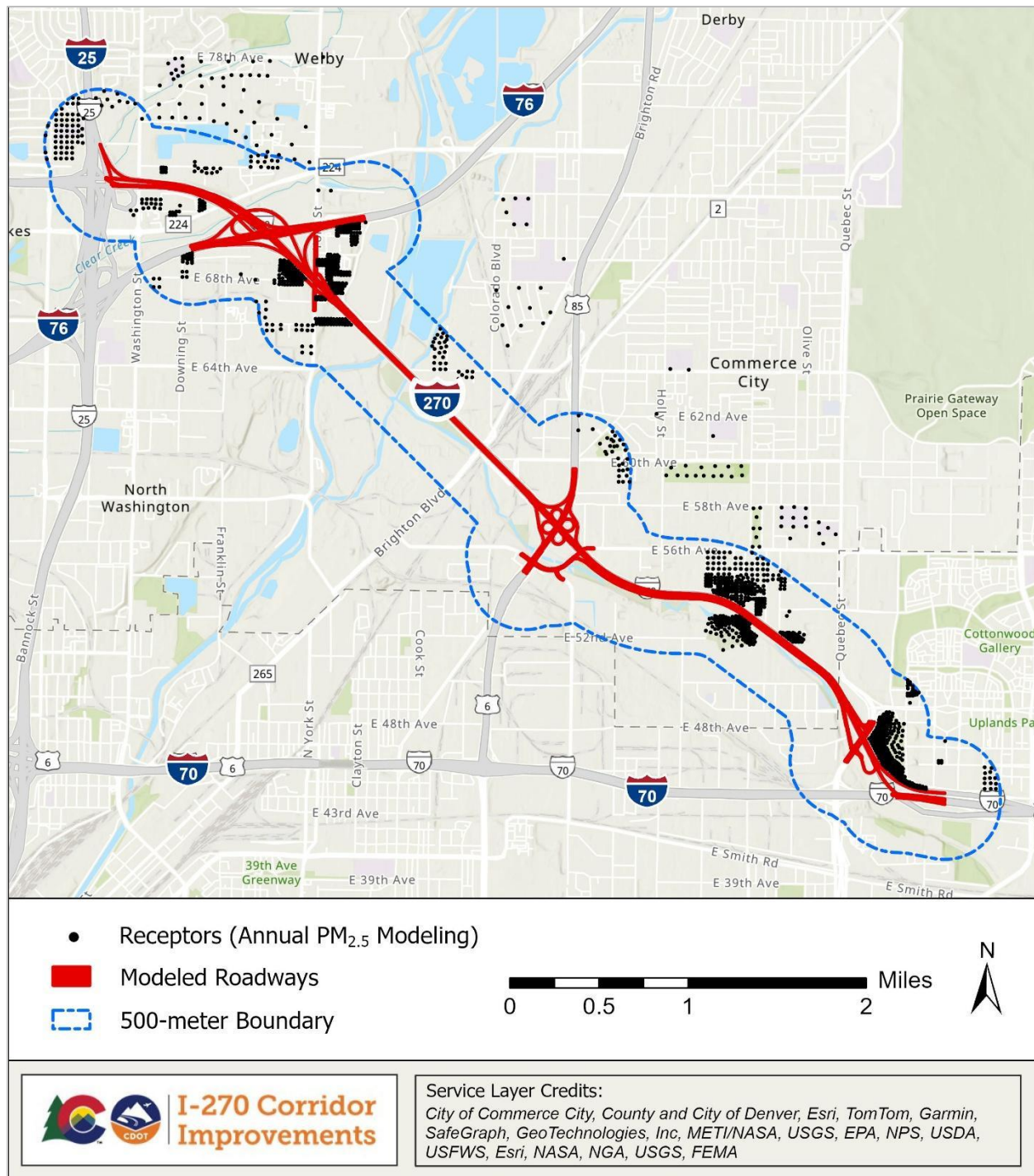


Figure 2. Map of the Receptor Network Used to Model Annual Average $PM_{2.5}$.



3.0 Calculation of Design Concentrations

Design concentrations for 24-hour average PM_{10} and $PM_{2.5}$ and annual average $PM_{2.5}$ for each model receptor were calculated according to EPA's PM hot-spot guidance⁵⁶ by adding the background concentration to the appropriate modeled concentration and rounding the total.

The appropriate modeled concentration and rounding unit to use for each pollutant/averaging time are noted in the following descriptions of the calculation:

- PM_{10} (24-hour): Sixth highest 24-hour average modeled concentration (across the 5 years of meteorological data) plus background concentration, rounded to the nearest $10 \mu\text{g}/\text{m}^3$ (i.e., 155.000 rounds to 160, and 154.999 rounds to 150).
- $PM_{2.5}$ (24-hour): Average of 98th percentile (eighth highest) 24-hour average modeled concentration for the 5 years of meteorological data plus background concentration, rounded to the nearest $1 \mu\text{g}/\text{m}^3$.
- $PM_{2.5}$ (Annual): Annual average (across the 5 years of meteorological data) modeled concentration plus background concentration, rounded to the nearest $0.1 \mu\text{g}/\text{m}^3$.

⁵⁶ The guidance is available at <https://www.epa.gov/state-and-local-transportation/project-level-conformity-and-hot-spot-analyses>.

Appendix F. MSAT Discussion

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Transportation projects may affect regional or local air toxic concentrations due to the mobile source air toxic (MSAT) emissions from vehicles. Potential MSAT effects from the I-270 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 2023).

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. The EPA assessed this expansive list in its rule on the Control of Hazardous Air Pollutants from Mobile Sources (72 FR 8430), and identified a group of 93 compounds emitted from mobile sources that are part of EPA's Integrated Risk Information System (IRIS).⁵⁷ 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 non-cancer hazard contributors from the 2011 National Air Toxics Assessment (NATA).⁵⁸ These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (DPM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter. While FHWA considers these the priority mobile source air toxics, the list is subject to change and may be adjusted in consideration of future EPA rules.

2.0 National Trends in Mobile Source Air Toxic (MSAT) Emissions

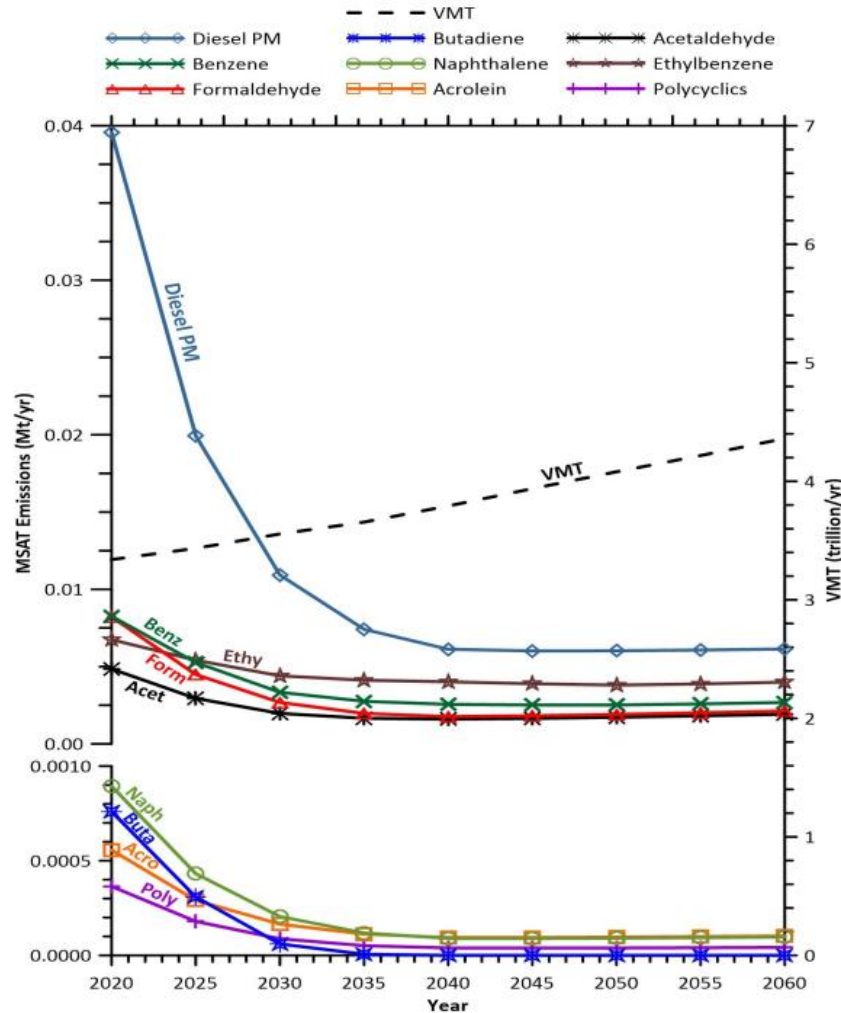
National trend data projects substantial overall reduction in MSAT emissions due to stricter engine and fuel regulations issued by EPA. Using EPA's MOVES3 model, as shown in Figure 1, FHWA estimates that even if vehicle miles traveled (VMT) increases by 31 percent from 2020 to 2060 as forecast, a combined reduction of 76 percent in the total annual emissions for the priority MSAT is projected for the same time period. DPM is the dominant component of MSAT

⁵⁷ See <https://www.epa.gov/iris>.

⁵⁸ See <https://www.epa.gov/national-air-toxics-assessment>. EPA has succeeded NATA with the Air Toxics Screening Assessment, or AirToxScreen (<https://www.epa.gov/AirToxScreen>).

emissions, making up 36 to 56 percent of all priority MSAT pollutants by mass, depending on calendar year (FHWA 2023).

Figure 1. FHWA projected national MSAT emissions trends from 2020 to 2060 for vehicles operating on roadways, based on EPA's MOVES3 model runs conducted by FHWA in March 2021 (FHWA 2023). 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.



3.0 MSAT Research

Air toxics 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 potential public 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 toxics 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 its environmental documents. The FHWA, EPA, the Health Effects Institute, and others have

funded and conducted research studies to try to more clearly define potential risks from MSAT emissions associated with highway projects. The FHWA will continue to monitor the developing research in this field.

4.0 Consideration of MSATs in NEPA Documents

The FHWA developed a tiered approach with three categories for analyzing MSATs in NEPA documents, depending on specific project circumstances:

- **No analysis for projects with no potential for meaningful MSAT effects.** The types of projects typically include projects qualifying as a categorical exclusion under 23 CFR 771.117, projects exempt under the conformity rule under 40 CFR 93.126, and other projects with no meaningful impacts on traffic volumes or vehicle mix.
- **Qualitative analysis for projects with low potential MSAT effects.** Projects in this category include those that improve operations of highways, transit, or freight without adding substantial new capacity or without creating a facility that is likely to meaningfully increase MSAT emissions.
- **Quantitative analysis to differentiate alternatives for projects with higher potential MSAT effects.** Projects in this category:
 - Create or significantly alter a major intermodal freight facility that has the potential to concentrate high levels of DPM in a single location, involving a significant number of diesel vehicles for new projects or accommodating 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 annual average daily traffic (AADT) is projected to be in the range of 140,000 to 150,000 or greater by the design year.

Projects in this category are also located near populated areas.

5.0 Quantitative Analysis of MSAT Emissions

The I-270 Corridor Improvements Project is located in the populated Denver metropolitan area. Compared with the No Action Alternative, the 3GPL and 2GPL+1EL alternatives are expected to have higher traffic volumes and increased daily VMT due to the addition of a lane on I-270. FHWA determined that the I-270 Corridor Improvements Project meets the criteria for projects with higher potential MSAT effects based on the AADT projected for the design year of the project and the addition of substantial new capacity. The project is also located in proximity to populated areas. Therefore, this project would have higher potential MSAT effects, and a quantitative analysis of the MSAT emissions was conducted in accordance with FHWA's MSAT guidance (FHWA 2023).

Emissions of the nine priority MSAT pollutants for existing conditions in the year 2023 (for the No Action Alternative) and future conditions from the No Action Alternative, 3GPL, and 2GPL+1EL Alternatives in the design year 2050 were modeled using the MOVES4 model. Input parameters for the MOVES4 model are described in Appendix C of the Air Quality Technical Report.

The results of the quantitative MSAT emissions analysis are summarized in Table 1 and Table 2.

Table 1. NEPA Comparative Analysis of MSAT Air Pollutant Emissions (pounds per day) in January (Typical Weekday)

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
1,3-butadiene	0.549	0.000	0.000	0.000
Acetaldehyde	3.274	0.352	0.369	0.340
Acrolein	0.438	0.022	0.023	0.022
Benzene	4.898	0.832	0.939	0.882
DPM	53.093	0.819	0.876	0.800
Ethylbenzene	5.058	2.037	2.317	2.177
Formaldehyde	5.941	0.388	0.414	0.383
Naphthalene	0.699	0.020	0.022	0.021
Polycyclic Organic Matter	0.360	0.009	0.010	0.009

Table 2. NEPA Comparative Analysis of MSAT Air Pollutant Emissions (pounds per day) in July (Typical Weekday)

Pollutant	2023 Existing	2050 No Action	2050 3GPL	2050 2GPL+1EL
1,3-butadiene	0.616	0.000	0.00	0.000
Acetaldehyde	3.317	0.358	0.376	0.346
Acrolein	0.445	0.024	0.025	0.023
Benzene	6.662	1.206	1.367	1.285
DPM	53.093	0.819	0.876	0.800
Ethylbenzene	5.331	2.110	2.403	2.258
Formaldehyde	6.107	0.407	0.436	0.404
Naphthalene	0.717	0.023	0.026	0.024
Polycyclic Organic Matter	0.367	0.010	0.011	0.011

The VMT estimated for the 3GPL and 2GPL+1EL Project Alternatives 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, MSAT emissions under the 2050 No Action, 3GPL, and 2GPL+1EL alternatives are substantially lower than those of the 2023 Existing Conditions in the study area. In other words, MSAT emissions in the study area are expected to be lower in the future than they are today. The much larger decrease in estimated emissions of DPM between 2023 and 2050 compared to the other MSAT is most likely a result of Colorado's adoption of the Advanced Clean Trucks rule and the corresponding increase of electric vehicles in the medium- and

heavy-duty truck fleets by 2050. MSAT emissions under the 3GPL and 2GPL+1EL alternatives are slightly higher than those in the 2050 No Action Alternative for most MSAT pollutants due to the projected increase in VMT.

6.0 Incomplete or Unavailable Information for Project-Specific MSAT Health Impact Analysis

The MSAT analysis for the project includes a basic analysis of the likely MSAT impacts of the future Build Alternatives. Due to the limitations of information and methodology of the analysis, the following discussion is included in accordance with Appendix C of the FHWA *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents* (FHWA 2023). The discussion is prototype language taken directly from that Appendix.

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.

The EPA is responsible for protecting the public health and welfare from any known or anticipated effect of an air pollutant. They are the lead authority for administering the CAA and its amendments and have specific statutory obligations with respect to hazardous air pollutants and MSAT. The EPA is in the continual process of assessing human health effects, exposures, and risks posed by air pollutants. They maintain IRIS, which is "a compilation of electronic reports on specific substances found in the environment and their potential to cause human health effects" (EPA, <https://www.epa.gov/iris/>). Each report contains assessments of non-cancerous 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 the Health Effects Institute (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 2023). 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 is the adverse human health effects of MSAT compounds at current environmental concentrations⁵⁹ 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

⁵⁹ See HEI Special Report 16, *Mobile-Source Air Toxics: A Critical Review of the Literature on Exposure and Health Effects*, <https://www.healtheffects.org/publication/mobile-source-air-toxics-critical-review-literature-exposure-and-health-effects>.

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 attributable to a 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 MSAT because of factors such as low-dose extrapolation and translation of occupational exposure data to the general population, a concern expressed by HEI.⁶⁰ 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 DPM. The 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.”⁶¹

There is also the lack of a national consensus on an acceptable level of risk. The current context is the process used by the 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 1 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 1 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.⁶²

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

⁶⁰ Ibid.

⁶¹ See EPA IRIS database, Diesel Engine Exhaust, Section II.C., https://iris.epa.gov/static/pdfs/0642_summary.pdf.

⁶² United States Court of Appeals for the District of Columbia Circuit. 2008. No. 07-1053. Natural Resources Defense Council and Louisiana Environmental Action Network, Petitioners v. Environmental Protection Agency, Respondent American Chemistry Council, Intervenor.

fatalities, plus improved access for emergency response, that are better suited for quantitative analysis.

7.0 References

Federal Highway Administration (FHWA). 2023. *Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents*. HEPN-10. January 18.
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