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Air Quality Overview

AIR QUALITY OVERVIEW

FOR

RETHINKING I-94

In the Cities of Minneapolis and St. Paul,

And the Counties of Hennepin and Ramsey, Minnesota

January 2018

(Updated June 2018)

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Executive Summary

Air quality is defined by many different aspects, including different pollutants, the quantities of their emissions, their concentrations in the air we breathe, and the impacts that they may cause. Air quality plays a role in human health, quality of life, and the environment. Air quality can also play a role in economic impacts when mitigation strategies are required.

When project alternatives are developed for the Rethinking I-94 project, air quality will be addressed with detailed analyses. At this time, the project has yet to develop sufficient details to proceed with detailed air quality analyses.

CURRENT AIR QUALITY ALONG THE CORRIDOR

All transportation-related pollutants currently meet standards in the Rethinking I-94 project area.

TYPES OF POLLUTANTS FROM TRANSPORTATION SYSTEMS

Three main groups of pollutants are produced by transportation-related activities: greenhouse gases, criteria pollutants, and Mobile Source Air Toxics (MSATs).

Greenhouse gases in the upper atmosphere can cause climate change. The primary transportation-related greenhouse gas is carbon dioxide (CO_2).

Criteria pollutants are regulated by the US Environmental Protection Agency (EPA) and are a concern for human health in the air we breathe. There are four transportation-related criteria air pollutants:

- Ground-level ozone (O_3, or "tropospheric ozone")
- Particulate matter (PM_{10} and $PM_{2.5}$)
- Nitrogen oxides (NO_X),
- Carbon monoxide (CO).

MSATs are also regulated by the EPA, including 188 air toxics, also known as hazardous air pollutants. 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).[1] These are 1,3-butadiene, acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), ethylbenzene, formaldehyde, naphthalene, and polycyclic organic matter.

[1] https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/#ftn4

TRENDS

Vehicle emission controls, vehicle fuel efficiency, and fuel formulas continue to improve. Despite increasing numbers of trips and miles traveled, emissions continue to decline as a result of these improvements.

Transportation-related trends of air pollution emissions in Hennepin and Ramsey Counties is predicted to match national trends, showing a significant decrease in emissions over the next three decades.

TRANSPORTATION TECHNIQUES TO REDUCE AIR POLLUTION

Project specific measures implemented will likely have a much smaller influence on air pollutant emissions and air pollutant concentrations in the immediate project area than the vehicle technology and fuel formula trends discussed above.

Impacts, as defined by the Federal Highway Administration (FHWA), are not anticipated in the corridor as a result of any transportation project that may occur through the Rethinking I-94 process. Therefore, mitigation measures specifically implemented to reduce air pollutant emissions are unlikely to occur.

Any transportation system techniques to minimize air pollution would include a focus on minimizing traffic congestion. This could be accomplished through reducing congestion by providing sufficient roadway capacity and through methods to minimize vehicle miles traveled with multi-modal options, including transit, carpooling, and non-motorized transportation.

Introduction

This report provides background air quality information that characterizes the air quality environment as it relates to the Rethinking I-94 project. Information provided includes existing air quality levels in the project area, and trends that are anticipated to occur in the future.

The primary topics of this report include pollutant sources, air quality impacts, and means by which this project might help reduce pollutant emissions. A number of other topics are included, though it is unlikely that changes under the control of any project within the I-94 corridor will cause significant differences in pollutant emissions. For instance, the project itself cannot change whether the vehicle fleet improves by implementation of hybrid or electric vehicles. The main elements that might be under the control of the project are the capacity provided, the operating speeds, and the location of facilities, such as access points, and physical location of roadway lanes. In all respects, air quality is meeting federal standards in the project area, and therefore, no air quality mitigation is likely to be required as part of the project. Any specific project elements that are included in the project for purposes of changing air quality will provide mostly subjective changes to air quality, particularly as it relates to the overall pollutants emitted in the project area, but also in terms of air quality concentrations in the immediate vicinity of the project corridor.

This document also addresses a number of topics and potential concerns that have been raised through stakeholders or public involvement as part of the project.

Significant documentation and reports exist regarding the topic of air quality. The purpose of this document is to provide general information relevant to the Rethinking I-94 project. A listing of a number of references are provided within the document. Two most relevant documents that provide excellent background air quality information, include:

The Air We Breathe; The State of Minnesota's Air Quality 2017, Minnesota Pollution Control Agency (MPCA).

Life and Breath; How Air Pollution Affects Public Health in the Twin Cities, July 2015, Minnesota Department of Health (MDH) and MPCA.

WHAT IS AIR QUALITY?

When we say "Air Quality", we think about pollutants in the air we breathe, produced by a number of man-made sources such as cars, trucks, and industry. Some pollutants are also naturally occurring, but are described as a pollutant due to man-made contributions, such as Carbon Dioxide (CO_2).

Some key ingredients that all comprise "air quality:"

- Pollutant Sources
- Pollutants
- Health Impacts

- Environmental Impacts
- Geographic scale
- Persistence

For each item on the list above, there are many components. Pollutant sources include transportation, industry, agriculture, and recreation. The list of pollutants includes several categories, many of which have overlapping components. The groupings of pollutants can include greenhouse gases, mobile source air toxics, and criteria pollutants. Health Impacts can be broken into four groups: cardiovascular, respiratory, irritation, and toxic effects. Impacts can include irritation to throat and eyes, difficulty breathing, triggering bronchitis and asthma attacks, cancer, and heart attacks. In many cases these impacts are more significant for the young and elderly. Environmental Impacts include climate change, acid rain, reduced visibility and ground-level ozone (smog). Geographic scale refers to the fact that some pollutants and impacts are localized, such as carbon monoxide (CO) concentration at an intersection, compared to CO_2 impacts to climate change, usually reported in tons per year. Persistence refers to the fact that some pollutants decay faster, and are of a more localized concern than others through biological processes or dispersion, such as CO or particulates, compared to some pollutants that decay slower, and are of a more global concern, such as CO_2.

Generally, greenhouse gases affect the environment, but don't directly affect our health. Greenhouse gases are primarily CO_2, but also include a number of other pollutants that trap heat in the atmosphere causing climate changes.

On a more localized level than greenhouse gases, Criteria Pollutants and Mobile Source Air Toxics (MSATs) are pollutants that can directly affect human health. The EPA labels six pollutants "Criteria" because they are regulated by developing human health-based and/or environmental-based criteria for permissible levels[2]. The six criteria pollutants include the following:

- Particulate Matter (PM)
- Ground-Level Ozone (O_3)
- Carbon Monoxide (CO)
- Sulfur Dioxide (SO_2)
- Nitrogen Dioxide (NO_2)
- Lead (Pb)

Of the six criteria pollutants, Ozone and PM are the largest contributors to wide spread health effects. The six criteria pollutants are caused by multiple sources, including but not limited to, stationary sources (powerplants and gas stations) and mobile/transportation sources (cars, trucks, and planes).

In general, emissions increase with increased vehicular mileage. Therefore, reducing vehicle mileage results in lower overall emissions, and can be accomplished with higher vehicle occupancy through

[2] Source: The Plain English Guide to the Clean Air Act – United States of America Enviromental Protection Agencey (EPA), 2007.

better transit and carpooling opportunities. Congested traffic generally produces higher amounts of pollutant emissions than freely flowing traffic. Therefore, serving the same number of vehicle miles operating with less congestion and higher operating speeds, will generally result in lower emissions. An exception to this is when average vehicle operating speeds begin to exceed approximately 65 mph. The best situation from a transportation-related air quality perspective, is to maximize vehicle ridership, while simultaneously minimizing vehicle mileage and congestion.

Sources of Air Pollution

Transportation is the second largest source of pollution in the Twin Cities, comprising 24% of emissions in Minnesota, following 33% from non-permitted sources including small businesses, heating and woodsmoke, followed by 22% from permitted sources such as power plants and factories, and followed by 21% from off-road vehicles for purposes of construction and agriculture.

Pollution sources include:

- Transportation
- Point source emissions from facilities,
- Fuel combustion at commercial, industrial and institutional facilities,
- Construction,
- Agricultural equipment,
- Recreational equipment,
- Residential woodburning,
- Prescribed fires and wildfires

Most transportation emissions are emitted from vehicle tailpipes. However, there are a number of other transportation-related sources of emissions. Transportation air pollution sources can include the following:

- Internal Combustion emissions through vehicle tailpipes
- Evaporative losses from vehicles
- Tire wear
- Brake wear
- Refueling evaporation emissions
- Particulate re-entrainment (dust from the roadway)

[3] Source: The Air We Breathe, The State of Minnesota's Air Quality, MPCA, 2017, (https://www.pca.state.mn.us/sites/default/files/lraq-1sy17.pdf)

Transportation emissions were reduced by 58% between 1990 and 2014 (VOCs, SO_2, NO_X, and directly emitted $PM_{2.5}$).

Greenhouse Gases

Greenhouse gases affect the environment, but don't directly affect our health. Indirect health impacts include skin cancer and cataracts. Carbon dioxide is the greenhouse gas of primary concern, but greenhouse gases also include a number of other pollutants. Greenhouse gases trap heat in the atmosphere, causing climate changes.

The main greenhouse gases are:

- Carbon Dioxide (CO_2)
- Methane (CH_4)
- Nitrous Oxide (N_2O)
- Fluorinated gases

Some of the primary sources of greenhouses gases in the Unites States are:

- Electricity Generation
- Transportation
- Industrial Activities
- Commercial and Residential Activities
- Agriculture
- Land Use and Forestry Activities

A direct result of burning fossil fuels is the emission of CO_2.

Criteria Pollutants

There are six common air pollutants, called “criteria air pollutants.” These pollutants are gaseous or air-borne chemicals, molecules, and particles found across the US and are known to pose risks to health and the environment. They have many sources, some natural such as forest fires and common biological processes, and others caused directly by human activities, including combustion engines, chemical refining processes, and electricity generation. Because elevated levels of these six pollutants are known to be dangerous to human health and the surrounding environment, the Clean Air Act requires the United States Environmental Pollution Agency (US EPA, herein EPA) to set air quality standards via the National Ambient Air Quality Standard (NAAQS) to determine the acceptable concentration of these pollutants at a discrete monitoring location. The six criteria air pollutants are ground-level ozone (O_3, or “tropospheric ozone”), particulate matter (PM_{10} and $PM_{2.5}$), Nitrogen Oxides (NO_2), Sulfur Oxides (SO_X), lead (Pb), and Carbon Monoxide (CO). Of these six, four are directly associated with transportation emissions – CO, NO_X, SO_2, and particulate matter – and one, ground-level ozone, is the result of chemical reactions between NO_X and VOCs in sunlight.

GROUND-LEVEL OZONE

Ground-level ozone (O_3, or tropospheric ozone) is not emitted directly by vehicles but occurs as the result of a chemical reaction between NO_X and VOCs in the presence of sunlight (VOCs are air toxics, and described below in this report). Due to the reaction only taking place in sunlight, ground-level ozone is present in greater levels on sunny, warm days. This chemical reaction also accounts for ozone travelling far afield from the pollutant source via wind where NO_X carries oxygen particles through the air to react with VOCs farther away. Exposure to ozone can cause difficulty breathing, damaged airways, and aggravate existing lung diseases. Ground-level ozone can have noticeable impacts on the environment as it is the primary cause of smog, acid rain, and nitrogen loading in costal water bodies.

PARTICULATE MATTER

Particulate matter describes any small solid particle or liquid droplet suspended in the air and can be made up of hundreds of different chemicals and compounds. PM is the result of natural processes (in dust, smoke, and pollen, for example) as well as human-made sources like industrial processing and combustion engines. Vehicles specifically are of concern as they not only generate large particulates by tire and brake wear, but can also create finer particles due to secondary chemical reactions. PM is categorized in to two sizes, as the different sized particles have different ranges by which they can be transported by air from the source and differing impacts on health and the surrounding environment. The two general size divisions are PM_{10}, also called course particulate matter, and $PM_{2.5}$, or fine particulate matter. Altogether, particulate matter is among the most harmful of all air pollutants. Generally, short-term exposure can cause irritation in the airways and eyes, and any exposure can bring very small particles in to the lungs. The smallest of those particles can travel from the respiratory system into the blood stream and interfere with the circulatory system. Long-term exposure to PM is known to contribute to the development of asthma and lung disease, and can also contribute to the development of cancer and cardio-pulmonary disease. It is generally agreed that there is no 'safe' exposure level to PM, as even the smallest exposure carries the risk of this kind of deep infiltration.

PM_{10}

PM_{10} consists of particles with a diameter of less than 10 micrometers, about 1/7 the thickness of a single human hair. It includes small particles such as road dust, tire particles, and brake dust that occur on roadways. Transportation is the cause of approximately 54% of PM_{10} emissions (EPA, 2005 National Emissions Inventory), while other sources include construction dust, wood burning stoves and fireplaces, wildfires, and industrial sources. Upon inhale, PM_{10} travels in to the respiratory system and settles in the lungs. Once there, these particles aggravate existing lung conditions (such as asthma, bronchitis, and other lung diseases) and reduce the body's ability to fight infections. For sensitive populations such as children, the elderly, exercising adults, and individuals suffering from asthma or bronchitis, this impact is particularly concerning.

$PM_{2.5}$

Smaller than PM_{10}, $PM_{2.5}$ consists of microscopic particles that have diameter of less than 2.5 micrometers. $PM_{2.5}$ is the most abundant size of particulate matter, accounting for approximately 90% of all PM (WHO, Health Aspects of Air Pollution, 2003). While particles of this kind are produced to a small degree by natural processes (in smoke, ash, and sea spray) emissions from transportation and other human activities account for a larger portion of these particulates in the atmosphere. $PM_{2.5}$ is the most concerning of all pollutants, as these microscopic particles enter the lungs upon inhale travelling in to the bloodstream and causing serious health conditions, damaging in both temporary and long-term exposure. Inhalation of PM causes respiratory system irritation, decreased lung function, and can contribute to heart attacks and irregular heartbeat.

NITROGEN OXIDES

Nitrogen oxides (NO_X) describes a family of seven compounds that are created by the burning of fuels at high temperatures. Emissions from mobile sources create different oxides of nitrogen (NO, NO_2, NO_3, etc.), but NO_2 is the most common of these compounds and is used as the measure by which to determine the presence of all NO_X in a given sample. Mobile sources – vehicles with combustion engines like those in cars, trucks, buses, planes and boats – accounted for approximately 59% of atmospheric NO_X in 2005 (EPA, 2005 National Emissions Inventory) and is the only compound of the six criteria air pollutants to be caused primarily by human activities. Like CO, NO_X combines with other pollutants in the atmosphere to create ground-level ozone as well as particulate matter. Once in the air, NO_X travels farther from its source than CO, as reactions with volatile organic compounds (VOCs) in the atmosphere can recycle NO to NO_2. Inhalation of NO_X irritates the respiratory system and may contribute to the development of asthma or increase susceptibility to other respiratory infections, especially in high-risk populations such as children and the elderly. Thus, an extended high concentration of NO_X near roadways can be concerning for nearby at-risk populations.

SULFUR OXIDES

Gaseous sulfur oxides (SO_X) are formed from the burning of fuel sources that contain sulfur. The family of sulfur oxides do not occur in high concentrations on roadways, but is concerning in environments where coal and oil are burned and in plants where crude oil is converted to gasoline. Like NO_X, SO_X is used as a general term to describe a whole group of compounds, of which SO_2 is most prevalent at ground level. Transportation emissions account for less of the total presence of this pollutant – 11% of the amount present in the atmosphere, while the biggest emitter of this pollutant is power plants and industrial facilities, which generate 67% of atmospheric SO_X by comparison (EPA, 2005 National Emissions Inventory). Also like NO_X, SO_X is highly reactive. Its reaction with other pollutants can create fine particulate matter ($PM_{2.5}$) and the compound transforms into acids when dissolved in to water vapor, which is damaging to the environment. Breathing SO_X negatively effects the respiratory system, causing difficulty breathing, and is concerning for at-risk populations. On its own, the impacts of SO_X to health are temporary and related to direct exposure, but it is this pollutant's chemical reactions that generate $PM_{2.5}$ which most concerning to health.

LEAD

Lead (Pb) as an airborne pollutant results from metals processing and the burning of leaded fuels. Since the EPA's regulation of lead in motor vehicle fuels in 1980, the presence of lead in the air has decreased 98% from 1980 to 2014. While this molecule is no longer produced by modern consumer vehicles, lead remains a criteria pollutant due to its production in ore and metals processing, and certain aircraft. Additionally, it is regulated due to the use of leaded fuels in non-road equipment (including locomotives, ships, and planes) and is still sold in small amounts for specific applications such as race cars, farm equipment, and aircraft. The inhalation of airborne lead is dangerous to most populations, and in sufficient quantities causes damage to the nervous system, kidneys, immune system, reproductive and developmental systems, and the cardiovascular system. The most common health effect from lead exposure occurs in children as neurological problems and as cardiovascular effects in adults.

CARBON MONOXIDE

Carbon monoxide (CO) is released when any carbon fuel source is not burned completely. It occurs at low levels naturally as the result of biological processes in plants and animals and is also resultant from natural events such as forest fires and volcanoes. Though these natural processes create CO, the greatest source of CO in outdoor air is vehicles that burn fossil fuels, as it is a major component of motor vehicle exhaust. By itself, the compound only causes harm in high concentrations and is usually short-lived and disperses quickly from the source. However, its proximity to other pollutants in exhaust can cause chemical reactions which create ground-level ozone. High concentrations of CO can be dangerous for humans - breathing air with high CO concentration can cause dizziness and confusion, and after an extended period of exposure, it can cause unconsciousness and eventually death, although levels this high are unlikely to occur outdoors. Most populations are not exposed to high levels of CO, but extended exposure to elevated levels is of concern for people with certain types of heart disease and especially when those populations are exercising or under increased stress. Near roadways, high density traffic can cause a higher concentration of CO, although rarely above established NAAQS limits.

Mobile Source Air Toxics (MSAT)

The FHWA provides guidance for addressing MSATs in air quality documentation for federally funded projects. Utilizing the FHWA's MSAT guidance, this section provides an overall description of MSATs, along with some national trend data. A later section of this document, "Existing air quality in Minnesota," includes trend results of MSAT modeling for Hennepin and Ramsey Counties.

BACKGROUND

Controlling air toxic emissions became a national priority with the passage of the Clean Air Act Amendments (CAAA) of 1990, whereby Congress mandated that the EPA regulate 188 air toxics, also known as hazardous air pollutants. The EPA has assessed this expansive list in their latest rule on the Control of Hazardous Air Pollutants from Mobile Sources (Federal Register, Vol. 72, No. 37, page 8430, February 26, 2007), and identified a group of 93 compounds emitted from mobile sources that are listed in their Integrated Risk Information System (IRIS).[4]

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).[5] These are *1,3-butadiene,acetaldehyde, acrolein, benzene, diesel particulate matter (diesel PM), 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.

VOLATILE ORGANIC COMPOUNDS

Volatile organic compounds (VOCs) are any organic chemical that includes any compound of carbon that easily becomes a gas or vapor, excluding CO, CO_2, carbonic acid, metallic carbides or carbonates, and ammonium carbonate. They include the two key MSATs benzene and formaldehyde (which are resultant from the burning of gasoline), as well as some common solvents used in household products. VOCs are particularly concerning as they react with NO_X in sunlight to create ground-level ozone. Exposure to VOCs causes eye, nose, and throat irritation, dizziness, headache, skin reaction, and in high quantities are cause cancer in humans.

[4] http://www.epa.gov/iris/

[5] https://www.fhwa.dot.gov/environMent/air_quality/air_toxics/policy_and_guidance/msat/#ftn4

POLYCYCLIC ORGANIC MATTER

Polycyclic organic matter (POM) is a large class of compounds formed primarily in combustion. They include polycyclic aromatic hydrocarbon compounds (PAHs) and naphthalene, and are present in the atmosphere as a particulate. There is limited data available on the amount and concentration of POM emitted from any particular emitter (including cars and industrial facilities), but there has been a small extent of studies done on their presence in environments surrounding roadways and those facilities. Certain kinds of PAHs are probable carcinogens causing cancer in the form of respiratory tract, stomach, and lung tumors and leukemia.

DIESEL EXHAUST

Diesel exhaust (DE) is emitted by combustion engines that use diesel fuel. Like most vehicle combustion engines, they produce PM, NO_X, and CO, but in different ratios and total quantities compared to gasoline-fueled cars: a fraction of the amount of CO, but a much larger quantity of PM and NO_X. DE is thus significantly more harmful to humans than petrol exhaust. Aside from the abovementioned health impacts of PM, NO_X, and CO, diesel exhaust is considered a Group 1 carcinogen, known to cause lung cancer and has a positive association with bladder cancer.

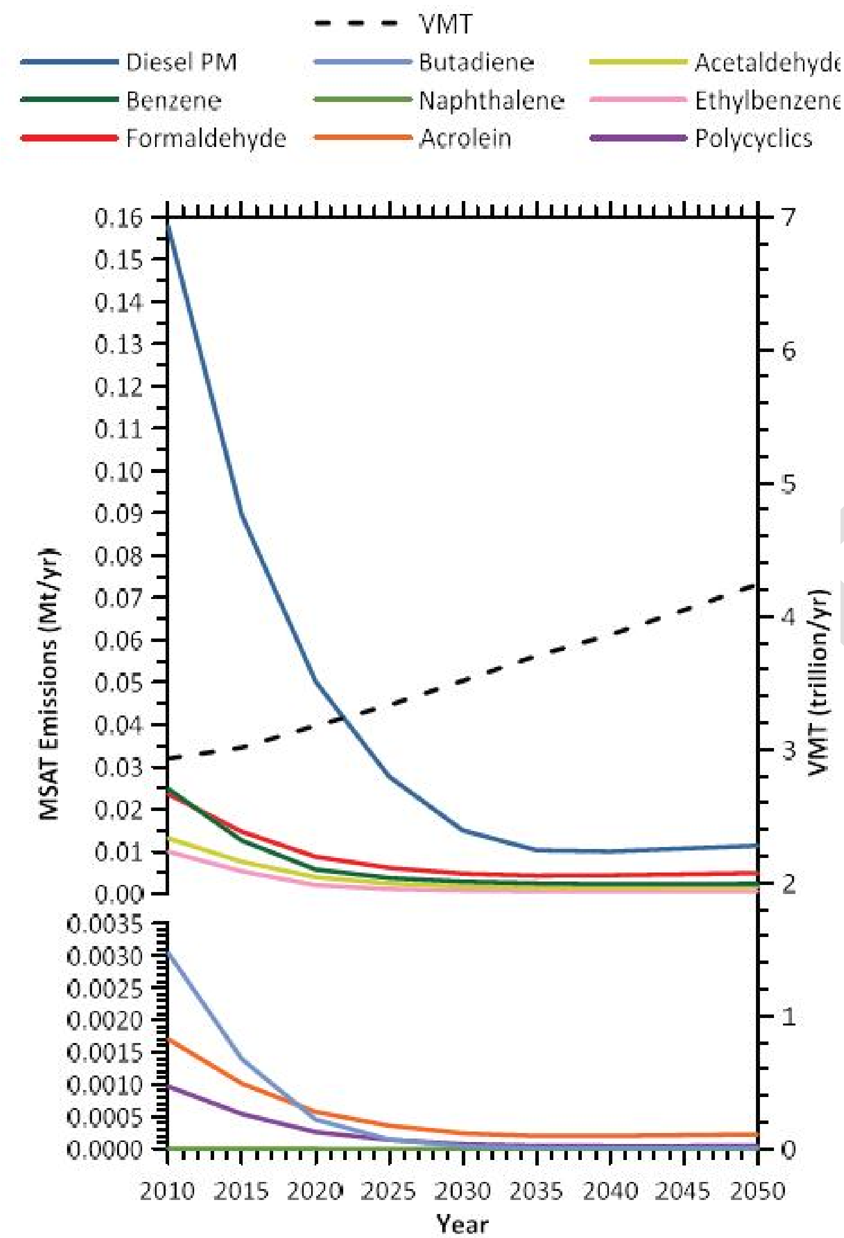
MOTOR VEHICLE EMISSIONS SIMULATOR (MOVES)

In 2014, the U.S. Environmental Protection Agency (EPA) released MOVES2014, the latest major update of the Motor Vehicle Emissions Simulator (MOVES) regulatory vehicle emission model. It incorporates data for emissions, fleet, and activity. These emissions data are for light- and heavy duty vehicles, exhaust and evaporative emissions, and fuel effects. MOVES2014 also includes updated vehicle sales, population, age distribution, and vehicle miles travelled (VMT) data. Since the release of MOVES2014, EPA has released MOVES2014a.

Using EPA's MOVES2014a model, as shown in Figure 1 below, FHWA estimates that even if VMT increases by 45 percent from 2010 to 2050 as forecast, a combined reduction of 91 percent in the total annual emissions for the priority MSAT is projected for the same period.

Diesel PM is the dominant component of MSAT emissions, making up 50 to 70 percent of all priority MSAT pollutants by mass, depending on calendar year.

Figure 1: National MSAT Emission Trends 2010 – 2050 for Vehicles Operating on Roadways Using EPA's MOVES2014a Model[6]



[6] Updated Interim Guidance on Mobile Source Air Toxic Analysis in NEPA Documents, FHWA, October, 2016

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, 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 NEPA.

Nonetheless, air toxics concerns continue to be raised on highway projects during the NEPA process. Even as the science emerges, we are duly expected by the public and other agencies to address MSAT impacts in our 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.

Existing air quality in Minnesota

The State of Minnesota currently meets or beats all the federal standards for the criteria air pollutants. However, the MPCA highly prioritizes reducing the air pollution in Minnesota as "even low and moderate levels of air pollution can contribute to serious illnesses and early death" (MPCA, "Life and Breath: How Air Pollution Affects Public Health in the Twin Cities"). On most days, the outdoor air quality across Minnesota is good and are not expected to negatively impact health. However, the MPCA continues to try to improve the air quality in Minnesota by measuring air quality across the state and by identifying point sources that may be of concern. Through this effort and due to other factors (see advancing technology section, below) Minnesota has had decreasing aggregate emission levels since 1990. The specific amounts are published by the MPCA in a yearly report called "The State of Minnesota's Air Quality".

"The Air We Breathe: The State of Minnesota's Air Quality 2017" indicates that levels of pollution in outdoor air have been going down for nearly all measured air pollutants and generally has been improving. Historically, the largest pollutant generator in the state has been large facilities like power plants and factories. However today, most of Minnesota's air pollution comes from smaller sources within neighborhoods such as cars, local businesses, heating and cooling systems, and yard/recreational equipment. Compared to the federal standard, Minnesota emissions for 2017 were as follows, measured in percent of the EPA's federal standard:

- Ozone
  - 8-hour: 93%
- Fine particles
  - Annual: 78%
  - 24-hour: 66%
- Lead
  - Gopher Resources (single highest source): 67%
  - Statewide: 13%
- Nitrogen Dioxide
  - Annual: 26%
  - 1-hour: 46%
- Carbon Monoxide
  - 8-hour: 19%
  - 1-hour: 7%
- Sulfur Dioxide
  - Annual: 4%
  - 24-hour: 4%
  - 1-hour: 15%

Even though Minnesota performs well on pollutant measurement and has better air quality than the federal standard meeting nearly all health benchmarks, progressing scientific research continues to lower the exposure level at which concentrations of pollutants are considered risky. Thus, the MPCA continues to aim for better air quality across the state, specifically aiming to lower pollutant presence in urban areas and near roadways. In order to determine the health impact of exposure levels in the metropolitan area, they also regularly examine hospitalizations and death compared to air quality in different regions of the Twin Cities.

In a 2015 study of fine particle pollution and ground-level ozone presence, the MPCA divided the Twin Cities urban/suburban area by ZIP code to measure and examine levels of those two pollutants in the region (MPCA, “Life and Breath: How Air Pollution Affects Public Health in the Twin Cities”). $PM_{2.5}$ and ozone were selected as the pollutants for the study as they are established causes of adverse health effects. The study was also specific to the Twin Cities as the metro area has elevated pollutant levels and greater asthma-related emergency department visits and hospitalizations compared to the rest of the state. Considering hospitalizations due to asthma attacks, heart attacks, heart and lung diseases, certain cancers, and death due to any of the above, the study summarizes the impact of air quality through the metropolitan area and compares it to exposure levels divided by averaged ZIP code.

Overall, the study found that pollutant level differences divided by ZIP code are small. Differences in the air pollution-attributable rates of disease and death by poverty and race are largely due to disparities seen in the underlying rates of disease. In studying the impact on health, the MPCA establishes that 13% of 2008 Twin Cities metro area deaths can be directly attributable to air pollution. Fine particle pollution was estimated to cause >2,100 deaths, >200 respiratory hospitalizations, 91 cardiovascular hospitalizations, and ~400 emergency visits for asthma, while ground-level ozone was estimated to cause ~20 deaths, ~14 hospital admissions, and ~57 emergency visits yearly. Even a 10% decrease in emissions of these pollutants would dramatically lessen the occurrence of hospitalizations and emergency visits due to the respiratory and cardiovascular impacts of common pollutants.

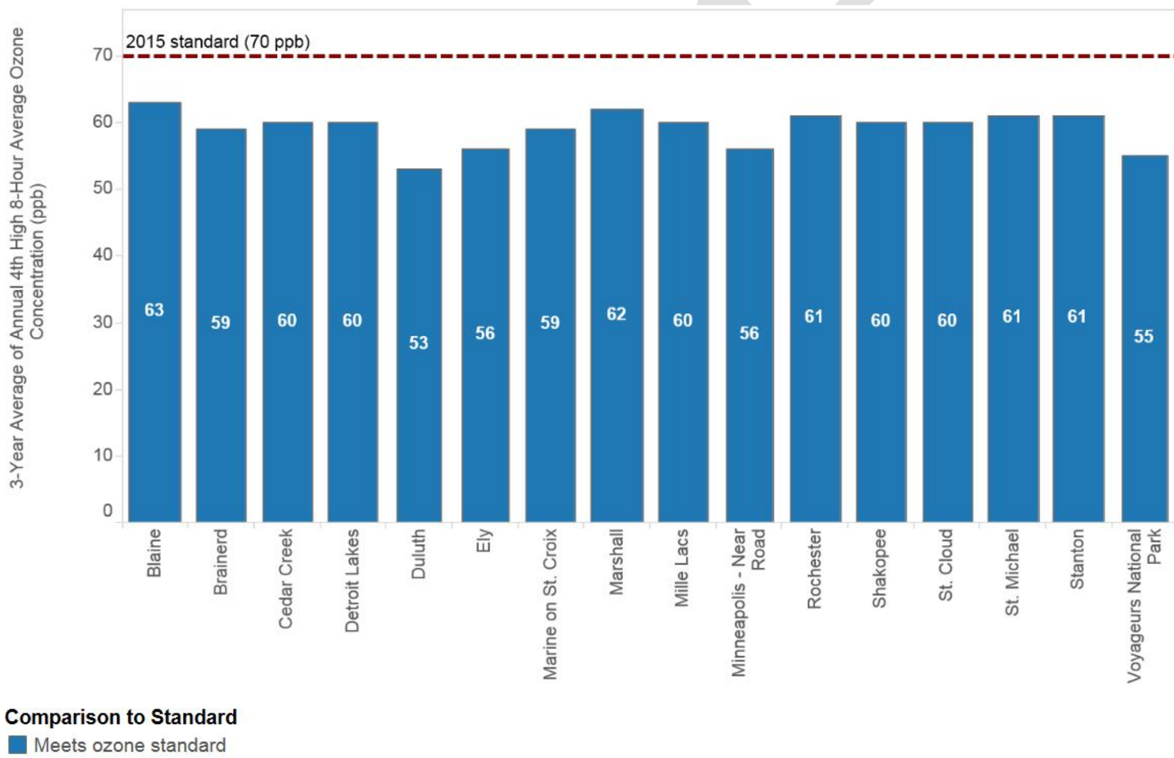
The majority of pollutants in Minnesota come from small-scale emitters. From the MPCA’s 2017 report, “The Air We Breathe”, on-road vehicles such as cars and trucks account for 24% of emissions, non-permitted sources (small businesses, heating, and wood smoke) 33%, off-road vehicles and equipment (construction and agricultural) 21%, and permitted sources including power plants and factories account for 22%. While we currently meet, or beat the EPA’s federal standards for emissions, improvement in roadway design, increased regulation, and advancing technology can reduce the presence of dangerous pollutants in Minnesota’s air and reduce the occurrence of hospitalizations in death due to these pollutants state-wide.

GROUND-LEVEL OZONE

The Minnesota Pollution Control Agency (MPCA), in cooperation with various other agencies, industries, and groups, has encouraged voluntary control measures for ozone and has begun developing a regional ozone modeling effort. Ozone concentrations in the lower atmosphere are influenced by a complex relationship of precursor concentrations, meteorological conditions, and regional influences on background concentrations. Minnesota is meeting the 2015 Ozone standards as demonstrated in Figure 2 below, which shows that measured locations in Minnesota are below the standard of 70 ppb.

Additionally, the State of Minnesota is classified by the EPA as an "ozone attainment area," which means that Minnesota has been identified as a geographic area that meets the national health-based standards for ozone levels. Because of these factors, a quantitative ozone analysis was not conducted for this project.

Figure 2: Ozone results compared to the 2015 standard (70 ppb), 2014-2016 [7]



[7] https://www.pca.state.mn.us/air/ozone-standard-minnesota

PARTICULATE MATTER

On December 14, 2012, the EPA issued a final rule revising the annual health NAAQS for fine particles ($PM_{2.5}$). The EPA website states:

With regard to primary (health-based) standards for fine particles (generally referring to particles less than or equal to 2.5 micrometers (mm) in diameter, PM2.5), the EPA is strengthening the annual PM2.5 standard by lowering the level to 12.0 micrograms per cubic meter (µg/m3). The existing annual standard, 15.0 µg/m3, was set in 1997. The EPA is revising the annual PM2.5 standard to 12.0 µg/m3 so as to provide increased protection against health effects associated with long- and short-term exposures (including premature mortality, increased hospital admissions and emergency department visits, and development of chronic respiratory disease), and to retain the 24-hour PM2.5 standard at a level of 35 µg/m3 (the EPA issued the 24-hour standard in 2006). The EPA is revising the Air Quality Index (AQI) for PM2.5 to be consistent with the revised primary PM2.5 standards.[8]

The agency also retained the existing standards for coarse particle pollution (PM_{10}). The NAAQS 24-hour standard for PM_{10} is 150 µg / m^3, which is not to be exceeded more than once per year on average over three years.

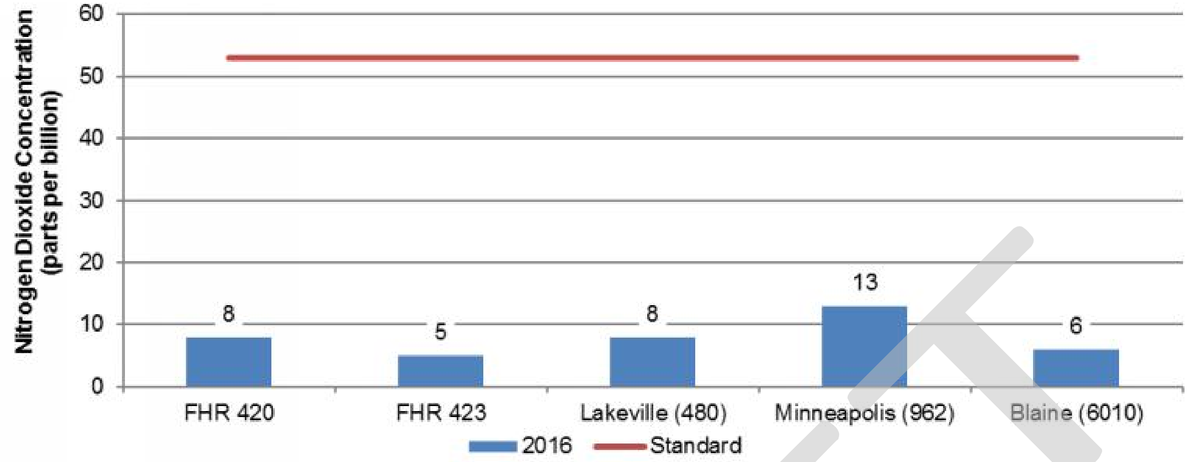
The Clean Air Act conformity requirements include the assessment of localized air quality impacts of federally-funded or federally-approved transportation projects that are deemed to be projects of air quality concern located within $PM_{2.5}$ nonattainment and maintenance areas. A small part of St. Paul is classified as a maintenance area for PM_{10}. This means that Minnesota has been identified as a geographic area that meets or exceeds the national standards for the reduction of PM levels, and the Rethinking I-94 project area is located outside of the maintenance area, and therefore is not likely to be considered concerning for PM impacts.

NITROGEN DIOXIDE (NITROGEN OXIDES)

Minnesota currently meets federal nitrogen dioxide standards, as shown in **Figure 3** below from *2018 Annual Air Monitoring Network Plan* (July 2017). This document states: “A monitoring site meets the annual NAAQS for NO_2 if the annual average is less than or equal to 53 ppb. The 2016 Minnesota averages ranged from 5 ppb at Flint Hills Refinery (FHR) 423 to 13 ppb at Minneapolis – Near Road 962; therefore, Minnesota currently meets the annual NAAQS for NO_2...”

[8] Source: http://www.epa.gov/pm/actions.html

Figure 3: Average Annual NO_2 concentrations compared to the NAAQS



In the *2018 Annual Air Monitoring Network Plan for Minnesota, July 2017*, it states the following with regard to the 1-hour NO_2 standard:

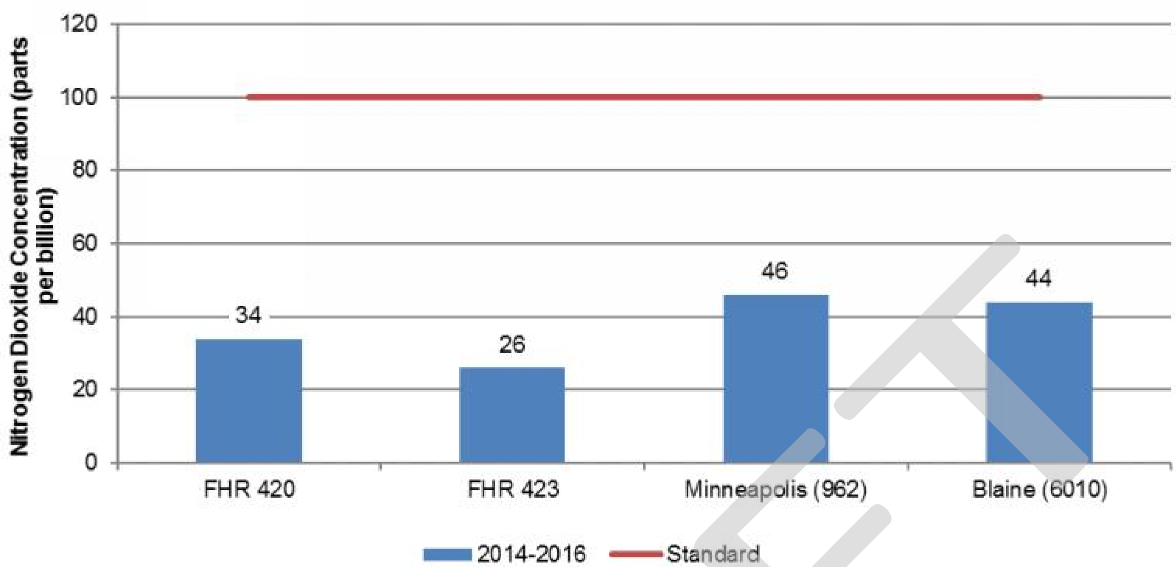
On January 22, 2010 the EPA finalized revisions to the NO_2 NAAQS. As part of the standard review process, the EPA retained the existing annual NO_2 NAAQS, but also created a new 1-hour standard. This new 1-hour NAAQS will protect against adverse health effects associated with short term exposures to elevated NO_2. To meet this standard, the three-year average of the annual 98th percentile daily maximum 1-hour NO2 concentration must not exceed 100 ppb. Minnesota averages ranged from 26 ppb at Flint Hills Refinery 423 to 46 ppb at Blaine (6010); therefore, all Minnesota sites currently meet the1-hour NAAQS for NO_2 (see Figure 4 below).

The EPA's regulatory announcement, EPA420-F-99-051 (December 1999), describes the Tier 2 standards for tailpipe emissions, and states:

The new tailpipe standards are set at an average standard of 0.07 grams per mile for nitrogen oxides for all classes of passenger vehicles beginning in 2004. This includes all light-duty trucks, as well as the largest SUVs. Vehicles weighing less than 6,000 pounds will be phased-in to this standard between 2004 and 2007.

As newer, cleaner cars enter the national fleet, the new tailpipe standards will significantly reduce emissions of nitrogen oxides from vehicles by about 74 percent by 2030. The standards also will reduce emissions by more than 2 million tons per year by 2020 and nearly 3 million tons annually by 2030.

Figure 4: 1-hour NO_2 concentrations compared to the NAAQS



Within the project area, it is unlikely that NO_2 standards will be approached or exceeded based on the relatively low ambient concentrations of NO_2 in Minnesota and on the long-term trend toward reduction of NO_X emissions. Because of these factors, a specific analysis of NO_2 was not conducted for this project.

SULFUR DIOXIDE

Sulfur dioxide (SO_2) and other sulfur oxide gases (SO_X) are formed when fuel containing sulfur, such as coal, oil, and diesel fuel is burned. Sulfur dioxide is a heavy, pungent, colorless gas. Elevated levels can impair breathing, lead to other respiratory symptoms, and at very high levels aggravate heart disease. People with asthma are most at risk when SO_2 levels increase. Once emitted into the atmosphere, SO_2 can be further oxidized to sulfuric acid, a component of acid rain.

MPCA monitoring shows that ambient SO_2 concentrations were at less than 20 percent of the federal standards over the 3-year period from 2014 through 2016, as shown in Figure 5 below.[9] The MPCA has concluded that long-term trends in both ambient air concentrations and total SO_2 emissions in Minnesota indicate steady improvement.

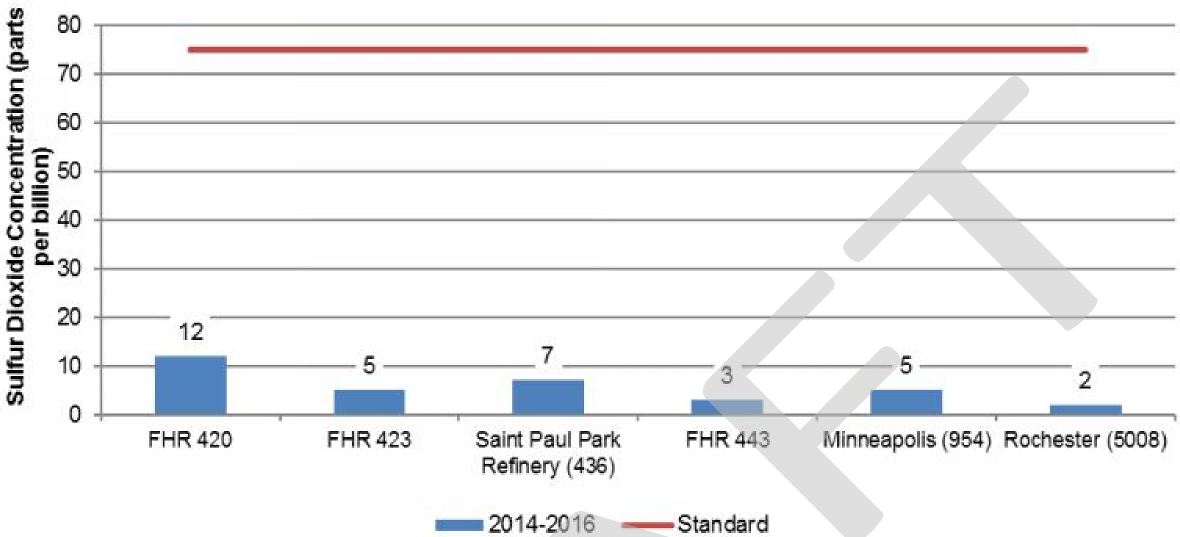
In the 2018 Annual Air Monitoring Network Plan for Minnesota, it states the following with regard to SO_2:

On June 2, 2010, the EPA finalized revisions to the primary SO_2 NAAQS. EPA established a new one-hour standard, which is met if the three-year average of the annual 99th percentile daily maximum one-hour SO_2 concentration is less than 75 ppb. Previous standards were revoked under the new rule. Minnesota

[9] Source: 2018 Annual Air Monitoring Network Plan for Minnesota, MPCA, July 2017

averages from 2014-2016 ranged from 2 ppb at Rochester (5008) to 12 ppb at Flint Hills Refinery (420); therefore, all Minnesota sites currently meet the one-hour NAAQS for SO_2.

Figure 5: 1-hour SO_2 concentrations compared to the NAAQS



Emissions of sulfur oxides from transportation sources are a small component of overall emissions and continue to decline due to the desulphurization of fuels. Additionally, the project area is classified by the EPA as a "sulfur dioxide attainment area," which means that the project area has been identified as a geographic area that meets the national health-based standards for sulfur dioxide levels. Because of these factors, a quantitative analysis for sulfur dioxide was not conducted for this project.

LEAD

Due to the phase out of leaded gasoline, lead is no longer a pollutant associated with vehicular emissions.

CARBON MONOXIDE

Carbon monoxide (CO) is the traffic-related pollutant that has been of concern in the Twin Cities Metropolitan area. In 1999, the EPA re-designated all of Hennepin, Ramsey, Anoka, and portions of Carver, Scott, Dakota, Washington, and Wright Counties as a limited maintenance area for CO. This means the area was previously classified as a nonattainment area but has now been found to be in attainment. This area includes the project area, which is located in Hennepin and Ramsey Counties.

Methodology

An analysis of the Hennepin and Ramsey County areas was conducted for this project. Similar to the FHWA analysis of MSATs presented in Figure 1 above in the section titled Mobile Source Air Toxics (MSAT) of this document, this analysis of Hennepin and Ramsey Counties demonstrates that the same air quality improvement trends are anticipated in the project area. Most pollutants show significant reductions as a result of improving emission controls in the vehicle fleet, and improved fuel mixture (i.e. low sulfur, no lead, etc.). These projected trends include the anticipated continuation of fleet and fuel mixture improvements. If, and when the project proceeds into further development, environmental documentation will likely be required. This future analysis and documentation would include a quantitative analysis of MSATs, consideration of hot-spot CO analysis, and an air quality conformity determination. Air quality conformity determinations are typically done on a regional level as part of the State Transportation Improvement Program.

This analysis includes both MSATs, as well as CO_2 equivalents, and the four transportation-related criteria pollutants.

This analysis uses the EPA's Motor Vehicle Emission Simulator (MOVES) tool. It is a state-of-the-art software for estimation of roadway vehicle emissions, based on analyses of millions of emissions test results and empirical data. MOVES takes into account a variety of factors that affect vehicle emissions, including vehicle age and fleet composition, roadway system classification, weather conditions, fuel type and technology, and various operating characteristics. The table below identifies each input file and the origin of the information within each file.

File	Source
Fuel related supply files	Defaults for Ramsey and Hennepin County (verified with MPCA)
Month VMT Fraction	MOVES Default
Day VMT Fraction	MOVES Default
Hour VMT Fraction	MOVES Default
Average Speed Distribution	MOVES Default
Vehicle Age Distribution	Received from MPCA
Road Type Distribution	Received from the MPCA
VMT File	Reported from Thrive MSP 2040

Following the guidance of the "Quick-start Guide for Using MOVES for NEPA MSAT Analysis" developed by the FHWA Resource center, a MOVES run specification was developed with a list of key input data tables.

The methodology for this analysis includes the following steps:

1. Prepare inputs for all the future years, including VMT estimation from the Thrive MSP 2040 Comprehensive plan;
2. Conduct a trend analysis through multiple future years to identify a trend in the emission of each of the pollutants;

This evaluation provides a comparison of emission levels resulting from various future conditions, but because dispersion modeling is not included, results do not yield exposure levels or assess whether changes in emissions are significant.

Trend Analysis

A trend analysis was completed for Hennepin and Ramsey Counties for year 2017 to year 2050 in 5 year increments.

Model input for this evaluation was obtained from a variety of sources as described above. Vehicle-type distribution and fleet mix for year 2010 was received from the MPCA. The Metropolitan Council's Thrive MSP 2040 long-range plan was used to estimate traffic inputs for each of the future year conditions, assuming increased travel and congestion levels. Thrive MSP 2040 indicates VMT to increase by 23% between 2010 and 2040. Inputs for the years between 2017 and 2050 were estimated by exponential growth interpolations. The difference in input datasets among all the analysis years include: total VMT and vehicle age population. Additional difference may occur, but are determined by the default values out of MOVES for each county and year. There include:

1. Fuel Mixture
2. Month VMT Fraction
3. Day VMT Fraction
4. Hour VMT Fraction
5. Speed Distribution
6. Ramp Fraction
7. Meteorological Data

The MSAT trend analysis results presented in Figure 6 below show that emission inventories for nine priority MSATs (Acrolein, Benzene, 1,3-Butadiene, Formaldehyde, Naphthalene, Polycyclic Organic Matte, Diesel PM) decrease significantly over the next three decades. In general, emissions will be approximately 80 percent lower in Hennepin and Ramsey Counties for year 2050 as compared to year 2017.

The trend analysis for the four transportation-related criteria pollutants, and CO_2 equivalents presented in Figure 7 below also shows a similar trend of reduction for these pollutants.

The analyses demonstrate that despite increasing VMT, the vehicle technology and fuel formula improvements result in decreasing emissions through approximately Year 2035, at which time slight increases are seen as a result of increased VMT, and stabilizing emission controls.

Figure 6: Hennepin and Ramsey County air quality analysis trends: Mobile Source Air Toxics (MSATs)

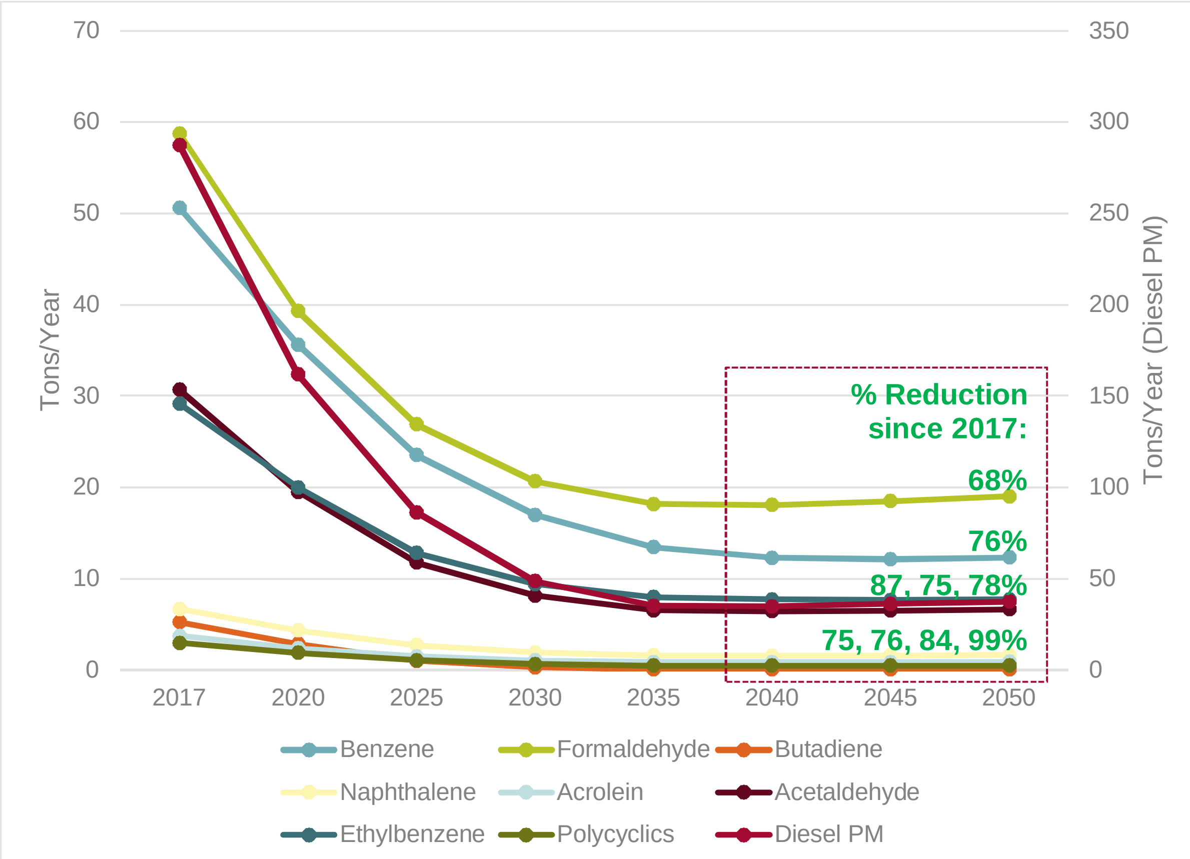
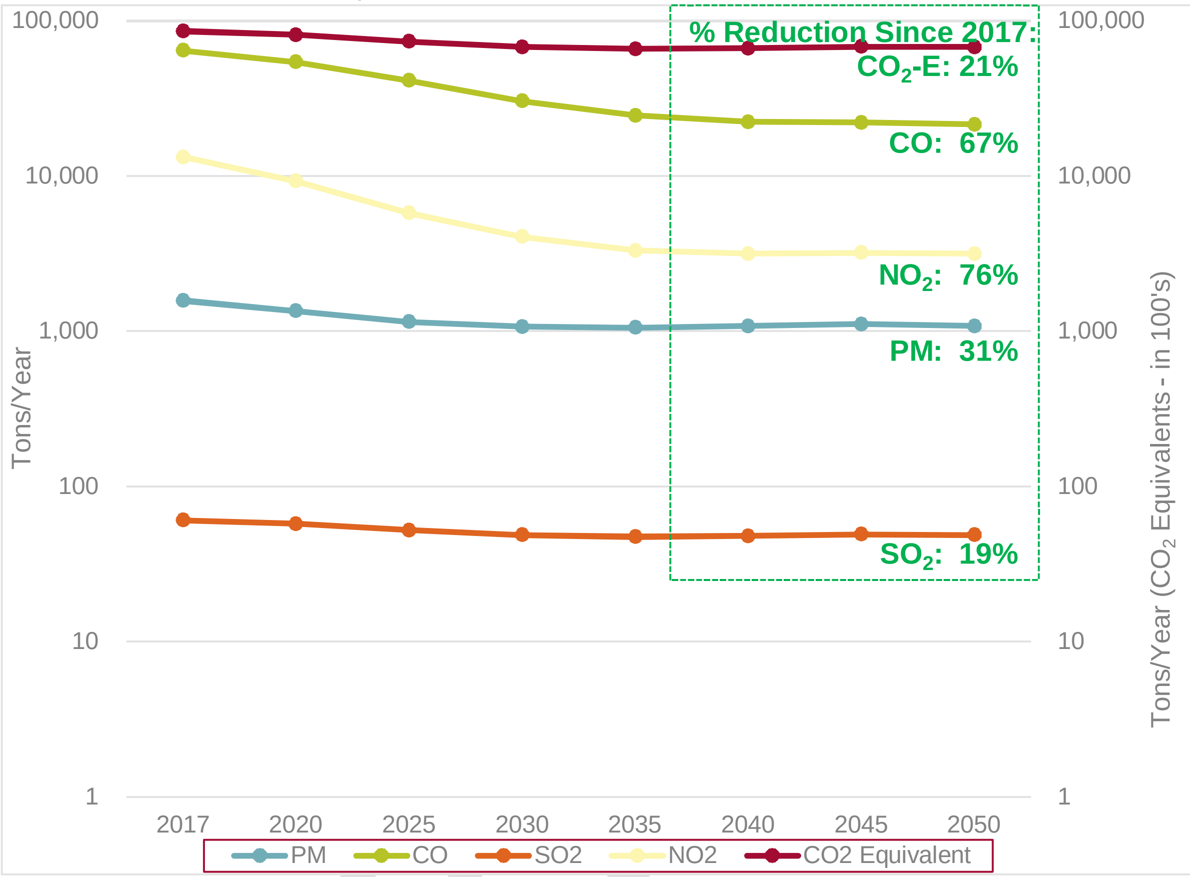


Figure 7: Hennepin and Ramsey County air quality analysis trends:
Criteria Pollutants and CO_2 Equivalents



Reducing Emissions

The EPA constantly revisits and revises federal standards for the criteria air pollutants and reviews new research on those pollutants as well as known air toxics to assess the exposure at which these pollutants are safe and the way that this information can be reflected in public policy. Stricter regulation causes industry to consider their impact on air quality and to innovate and invest in new technologies to continue to improve their performance on these markers. Emerging technologies in transportation and design continue to positively impact the emissions of cars, trucks, and transit vehicles. Additionally, roadway design can make a difference in the way pollutants reach close-proximity neighborhoods, especially in dense urban centers and communities near high-volume roadways.

ADVANCING TECHNOLOGY

Changes in engine, fuel, and vehicle design due to emerging technology can improve emissions from consumer vehicles, off-road vehicles, transit vehicles, diesel engines, farming equipment, planes, factories and virtually any fuel-burning engine that creates pollutants. In 2011, the Special Committee on Emerging Technologies examined, in-detail, current and emerging technologies at the time and their potential impact on emissions. The result was a report, titled "The Future of Vehicle Fuels and Technologies: Anticipating Health Benefits and Challenges". While the effort exhaustive, and not worth going far in-depth to here, the following list contains a few highlights from that article and their expected impact on emissions:

- Engine design – Improving engine designs and mechanisms can drastically change how an engine releases pollutants. Direct-injection engines, turbocharged and downsized gasoline engines, high-efficiency dilute gasoline engines, and homogenous charge compression ignition systems are some of the engine features that reduce gasoline consumption and have a different mechanism for combusting fuel which reduces pollutants. Some of them come at an expense however, in that they reduce one pollutants emission and increase others.
- Particle filters – Specially-designed filters within the exhaust pipe of vehicles can dramatically reduce PM emissions, especially from diesel engines which emit high volumes of PM. There are also technologies in development which create a chemical reaction in the tailpipe which prevents the release of NOX from diesel engines.
- Hybrid electric vehicles, plugin electric vehicles, fuel cell vehicles, and battery electric vehicles – This is a huge category which captures every kind of vehicle less dependent directly on combustion engines as a source of power. These vehicles reduce emissions resultant from gasoline usage compared to combustion-only vehicles and the battery electric and plugin electric vehicles are unique in they do not have any tailpipe emissions at all. Vehicles of this kind are currently the lowest-emitting vehicles on the market, and are being quickly adapted – by the end of 2015, 1.26 million electric vehicles were on the road worldwide (IEA, "Global EV Outlook", 2016).
- Ethanol fuel – Ethanol fuel is combined with gasoline in different quantities which reduces emission slightly compared to gasoline (E85 is the most commonly used and sold version of this fuel). Vehicles require a modified engine to use E85 and while vehicles that use it have reduced hydrocarbon, CO, and benzene emissions (especially reducing greenhouse gas emissions compared to gasoline), they increase ethanol, acetaldehyde, and NOX emissions.

Because of these technologies and others and their rapid adaptation in the public sector, the emission of most criteria pollutants and air toxics are steadily on the decline.

ROADWAY DESIGN

Different roadway designs can impact the permeation of mobile-source pollutants to nearby neighborhoods. According to the Health Effects Institute in a 2009 special report ("Traffic-Related Air Pollution: A Critical Review of the Literature on Emissions, Exposure, and Health Effects"), 30-45% of urban populations in the U.S. are likely exposed to increased pollution levels near roads. Certain features can improve this exposure and reduce the level of pollutants in the risk area (300-500 meters) and the exposure area (500-1,000 meters) from a major roadway.

In a 2009 article, "Can Roadway Design be Used to Mitigate Air Quality Impacts from Traffic?" the EPA examined different roadway designs and features and how they impacted nearby pollutant concentrations. Using wind tunnel studies, the study found that a roadway that is at-grade with no nearby roadway structures has the least amount of pollutant mixing and higher on-road presence of pollutants compared to roads with cut-section roads with vertical or sloped walls. A roadway that has either vertical or sloped walls in a cut-section encourages pollutant mixing and dispersion and lowers the concentration of pollutants near roads, although some studies indicate that on-road pollutants exist at a higher level in these sections, as they inhibit air movement off-road. Additionally, the turbulence inside these sections pushes pollution in to a more elevated plume compared to at-grade road conditions, which moves the pollution to a further elevation above the roadway. By comparison, an elevated, fill-section roadway causes higher downwind pollutant concentrations when the plume reaches ground-level, and thus generates higher concentrations of pollutants near roadways.

Structures near roadways alter the path of pollutants and their dispersion after leaving their source. A noise wall or barrier has the same effect on pollutant concentration as cut-section roads by encouraging pollutant mixing on the roadway through turbulence and releasing them higher vertically than a road without a noise barrier. Roads that are near buildings can also benefit from this effect as the buildings force emissions upward and away from the ground. Vegetation stands near roadways can have this effect as well, but have the added benefit of being porous which encourages mixing and dispersion and allows pollutants to settle on leaves and branches. Some studies all so indicate that vegetation may lower on-road levels compared to structures, as the porous quality of vegetation allows for air-flow to roadways.

It should be noted that controlling some of these parameters may be beyond the control of the Rethinking I-94 project. In addition, the differences are small and not quantified in these reports, leaving much of the aspects at a subjective level.

FREEWAY LIDS

The near-road air quality impacts became a focus of the EPA attention in recent years. One third of U.S. population lives and works within a relatively short distance of highways and may experience health effects of roadway pollution. Impacts of the roadway tunnels were analyzed as part of the near-road studies.

Tunnel emissions are generated by vehicles inside the tunnel and therefore impact the same pollutants of concern as the open roadway traffic emissions. The pollutants affected by roadway traffic are particulate matter, carbon monoxide, ozone, nitrogen oxide, MSAT and greenhouse gases. Depending on the traffic composition, impacts of some pollutants may be smaller as explained above in the Transportation Sources of Air Pollution section.

Short tunnels (lids) over freeways may increase connectivity of communities on both sides of a freeway and help control air quality and noise effects of the roadway. Vehicular emissions that are generated in the tunnel are exhausted at the exit portals or through vertical stacks, if mechanical ventilation provides for the vertical release. Mechanical ventilation for short tunnels could be needed for the fire safety reasons and may be longitudinal. Longitudinal ventilation, as opposed to transverse, moves air along the tunnel to the exit portals. Ventilation options are usually considered for the tunnels starting from 600-700 feet long. Shorter tunnels will be ventilated naturally by the piston action of moving vehicles.

As an added benefit, tunnels are also used to protect the sensitive land uses, such as schools, hospitals, parks, and residential areas, from the air pollution and noise impacts. Lids could be strategically placed in areas that are especially sensitive. However, to be effective, lids must be of certain length. Both dispersion of pollutants in the air and spreading of noise from an exit portal or a ventilation building bring pollutants and noise to receptors around the source and at the same time reduce their affect with distance. The first 300 foot of the radius around the traffic emissions source will experience the greatest impact.

As a rule, the air quality impacts of a short tunnel do not pose an air quality problem. However, the project sponsor may require an analysis to disclose the air quality levels near tunnel exhaust points, exit portals and exhaust stacks. The air quality impacts of the tunnels are added to the air quality levels at the areas near the exit portals and stacks. These levels are comprised from background concentrations and impacts of project-induced emissions including traffic emissions at the nearby streets and at the freeway downstream of the portals.

Most studies of tunnel air quality impacts were conducted for long tunnels that use mechanical ventilation. As an example, Central Artery/Tunnel in Boston (CA/T), MA (80 lane-miles) that was open to operations in 2006 was studied at the planning stage with analytical and wind-tunnel analyses performed for its main tunnels and shorter longitudinally-ventilated exit ramps. These analyses generated a number of papers presented and published by AWMA and TRB. The CA/T is a unique project that has a state air permit for its tunnel ventilation system. To our knowledge this is the only such permit in the U.S. and possibly in the entire world. The shorter tunnels were studied as part of projects, e.g., study of a series of short tunnels in Windsor, ON; studies of tunnels in Seattle (Alaskan Way Viaduct and Battery Street Tunnel improvements); a tunnel in Coronado, CA; extension of Prudential Tunnel in Boston; tunnels in New York (Miller Highway and on FDR); tunnels under Bosporus Straits, in Singapore, in Perth, Australia and at other locations. The results of these multiple studies give us a level of confidence to assess.