Air Quality

March 2021

CITY OF VENTURA
OUR VISION, OUR FUTURE

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Air Quality

This section of the Existing Conditions Report addresses topics related to regional and local air quality.

Key issue areas discussed in this section include:

- *Ventura County in the South Central Coast Air Basin (SCCAB) does not meet the State and federal standards for eight-hour ozone, or the State standard for one-hour ozone and particulate matter (PM_{10}), but is expected to be in attainment of the federal eight-hour ozone standard by July 2021.*
- *Continued regulatory and local focus on reducing vehicle miles traveled (Senate Bill 743) provides opportunities for air quality co-benefits because reductions in VMT equate to reductions in mobile emissions of criteria pollutants and toxic air contaminants, providing local and regional air quality benefits over time.*
- *The City may wish to consider expanding existing policies to encourage transportation demand management to include funding and development of VMT mitigation strategies, as local and regional programs to reduce VMT are established.*
- *The updated General Plan could establish policies and processes to address land use compatibility of sensitive receptors and sources of toxic air contaminants, as uses change, intensify and/or expand.*

Air Quality Regulation

The federal and California Clean Air Acts regulate the emission of airborne pollutants from various mobile and stationary sources. The U.S. EPA is the federal agency designated to administer air quality regulation, while the CARB is the state equivalent within the California Environmental Protection Agency. These agencies have established ambient air quality standards for the protection of public health. Local air quality management control and planning is provided through regional air districts established by the CARB for the 15 air basins statewide. The CARB is responsible for control of mobile emission sources, while local air districts are responsible for control of stationary sources and enforcing regulations. Ventura is located in the Ventura County portion of the South Central Coast Air Basin (SCCAB), which is under the jurisdiction of the Ventura County Air Pollution Control District (VCAPCD).

Ambient Air Quality Standards and Attainment Status

Six primary criteria pollutants are regulated by the federal Clean Air Act and California Clean Air Act. Primary criteria pollutants are emitted directly from a source (e.g., vehicle tailpipe, an exhaust stack of a factory, etc.) into the atmosphere. Primary criteria pollutants include: carbon monoxide (CO), nitrogen dioxide (NO_2), small particulate matter that measures no more than 10 microns in diameter (PM_{10}), fine particulate that measures no more than 2.5 microns in diameter ($PM_{2.5}$), sulfur dioxide (SO_2), and lead

(Pb). Ozone (O_3) is considered a secondary criteria pollutant because it is created by atmospheric chemical and photochemical reactions between reactive organic compounds (ROC[1]) and nitrogen oxides (NO_X). Appendix A provides background about each criteria pollutant. The U.S. EPA and the CARB establish ambient air quality standards for major pollutants at thresholds intended to protect public health. Federal and state standards have been established for O_3, CO, NO_2, SO_2, lead, PM_{10} and $PM_{2.5}$.

The VCAPCD monitors criteria pollutant levels in Ventura County to ensure that air quality standards are met, and if they are not met, develops strategies to meet the standards. Depending on whether or not the standards are met or exceeded, the county is classified as being in "attainment" or "nonattainment." Table 1 summarizes the California Ambient Air Quality Standards (CAAQS) and the National Ambient Air Quality Standards (NAAQS) for each of these pollutants and the attainment status for Ventura County. As shown therein, Ventura County is designated a nonattainment area for the federal and state eight-hour O_3 standards and the state one-hour O_3 and PM_{10} standards. This nonattainment status is a result of several factors, the primary ones being naturally adverse meteorological conditions that limit the dispersion and diffusion of pollutants, the limited capacity of the local airshed to eliminate air pollutants, and the number, type, and density of emission sources in the SCCAB.

[1] *Organic compound precursors of ozone are routinely described by a number of variations of three terms: hydrocarbons (HC), organic gases (OG), and organic compounds (OC). These terms are often modified by adjectives such as total, reactive, or volatile, and result in a rather confusing array of acronyms: HC, THC (total hydrocarbons), RHC (reactive hydrocarbons), TOG (total organic gases), ROG (reactive organic gases), TOC (total organic compounds), ROC (reactive organic compounds), and VOC (volatile organic compounds). While most of these differ in some significant way from a chemical perspective, two groups are important from an air quality perspective: non-photochemically reactive in the lower atmosphere, or photochemically reactive in the lower atmosphere (HC, RHC, ROG, ROC, and VOC). The VCAPCD uses the term ROC to denote organic precursors.*

Table 1: Federal and State Ambient Air Quality Standards and Attainment Status

Pollutant	Federal Standard	Attainment Status	California Standard	Attainment Status
Ozone	0.070 ppm (8-hr avg)	Nonattainment-Severe	0.09 ppm (1-hr avg) 0.070 ppm (8-hr avg)	Nonattainment Nonattainment-Severe
Carbon Monoxide	35.0 ppm (1-hr avg) 9.0 ppm (8-hr avg)	Attainment Attainment	20.0 ppm (1-hr avg) 9.0 ppm (8-hr avg)	Attainment Attainment
Nitrogen Dioxide	0.100 ppm (1-hr avg) 0.053 ppm (annual avg)	Unclassified Unclassified	0.18 ppm (1-hr avg) 0.030 ppm (annual avg)	Attainment Attainment
Sulfur Dioxide	0.075 ppm (1-hr avg) 0.5 ppm (3-hr avg) 0.14 ppm (24-hr avg) 0.030 ppm (annual avg)	Unclassified Unclassified Unclassified Unclassified	0.25 ppm (1-hr avg) 0.04 ppm (24-hr avg)	Attainment Attainment
Lead	0.15 μg/m^3 (rolling 3-month avg) 1.5 μg/m^3 (calendar quarter)	Unclassified Unclassified	1.5 μg/m^3 (30-day avg)	Attainment
Particulate Matter (PM_{10})	150 μg/m^3 (24-hr avg)	Attainment	50 μg/m^3 (24-hr avg) 20 μg/m^3 (annual avg)	Nonattainment Nonattainment
Particulate Matter ($PM_{2.5}$)	35 μg/m^3 (24-hr avg) 12 μg/m^3 (annual avg)	Unclassified Attainment	12 μg/m^3 (annual avg)	Attainment
Visibility-Reducing Particles	No Federal Standards	Not applicable	Extinction coefficient of 0.23 per kilometer – visibility of ten miles or more (0.07 - 30 miles or more for Lake Tahoe) due to particles when relative humidity is less than 70 percent. Method: Beta Attenuation and Transmittance through Filter Tape. (8-hr avg)	Unclassified
Sulfates	No Federal Standards	Not applicable	25 μg/m^3 (24-hr avg)	Attainment
Hydrogen Sulfide	No Federal Standards	Not applicable	0.03 ppm (1-hr avg)	Attainment
Vinyl Chloride	No Federal Standards	Not applicable	0.01 ppm (24-hr avg)	Attainment

ppm= parts per million; μg/m3 = micrograms per cubic meter; hr = hour; avg = average; nonattainment-severe = a nonattainment area with a design value [a statistic that describes the air quality status relative to the level of the NAAQS] from 0.105 ppm up to but not including 0.163 ppm); unclassified = the category given to an area with insufficient data)
Sources: CARB 2018a through 2018j; U.S. EPA 2020a through 2020h

Southern California Association of Governments Regional Transportation Plan/Sustainable Communities Strategy (RTP/SCS)[2]

Senate Bill 375 directs each of the state's 18 major Metropolitan Planning Organizations (MPOs) to prepare a "sustainable communities strategy" (SCS) that contains a growth strategy to meet passenger vehicle greenhouse gas (GHG) emission reduction targets for inclusion in the Regional Transportation Plan (RTP). On March 22, 2018, the CARB adopted updated regional targets for reducing GHG emissions from 2005 levels by 2020 and 2035. The Southern California Association of Governments (SCAG) was assigned targets of an 8 percent reduction in 2005 GHG emissions levels associated with passenger vehicles by 2020 and a 19 percent reduction in 2005 GHG emissions levels associated with passenger vehicles by 2035. Although these emission reduction targets are aimed at GHGs, they have the co-benefit of also reducing air pollutant emissions from passenger vehicles. Goals and policies included in the 2016-2040 RTP/SCS to reduce emissions include adding density in proximity to transit stations, planning for growth around livable corridors with mixed-use development, and encouraging active transportation (i.e., non-motorized transportation such as bicycling and walking). SCAG is currently reviewing the 2020-2045 RTP/SCS, "Connect SoCal" for adoption.

2016 Ventura County Air Quality Management Plan

Because Ventura County is currently designated nonattainment for the federal and state eight-hour O_3 standards and the state one-hour O_3 and PM_{10} standards, the VCAPCD is required to implement strategies to reduce pollutant levels to recognized acceptable standards. These strategies are contained in the 2016 Air Quality Management Plan (AQMP), which builds upon the 2007 AQMP and includes further demonstrations of reasonable progress toward the new federal eight-hour O_3 standard. The 2016 AQMP includes federal, state, and regional actions, local stationary source control measures, and transportation control measures (e.g., vehicle miles travelled reductions, increased vehicle occupancy, vehicle substitution, trip elimination, and technological improvements).

VCAPCD Rules and Regulations

The primary method by which the VCAPCD implements the AQMP is through adoption and enforcement of rules and regulations for emissions generated by various uses and activities. These rules and regulations include requirements for permits to construct and operate new stationary sources; standards for emissions of specific pollutants such as particulate matter, sulfur compounds, fugitive dust, hazardous materials and airborne toxics, and asbestos; restrictions on certain emissions sources such as incinerators, fuel combustion, crude oil production, abrasive blasting, architectural coatings, dry cleaning, and orchard heaters; protocols for source testing and stack monitoring; and requirements for the VCAPCD transportation outreach program.[3]

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[2] SCAG is in the process of reviewing and approving the 2020-2045 RTP/SCS. This section will be updated once the 2020-2045 RTP/SCS is fully adopted. https://www.connectsocal.org/Pages/Connect-SoCal-Final-Plan.aspx

[3] VCAPCD Rules available online at: http://www.vcapcd.org/Rulebook/RuleIndex.htm

Ventura General Plan Our Healthy and Safe Community Chapter

The City's current General Plan, specifically *Our Healthy and Safe Community* Chapter, provides policies and actions for the City to help improve local air quality conditions. Policies include appropriate siting of stationary sources and sensitive uses; requiring analysis and mitigation in accordance with VCAPCD recommendations; land use compatibility considerations for siting near agricultural and industrial land uses; and funding of regional transportation demand management programs (City of Ventura 2005).

Emerging Trends

Air quality in Ventura County continues to improve, as local strategies in the 2016 AQMP, statewide programs to reduce pollution from cars and trucks are implemented, and cleaner technologies (like electrification of cars, landscape equipment, rail, and buses) are more widely adopted. The statutory deadline for Ventura County to attain the federal eight-hour O_3 standard is July 20, 2021. The 2016 AQMP determines that, with implementation of the proposed control strategies, Ventura County can expect to reach attainment of the federal and state eight-hour O_3 standard by July 20, 2020; however, the determination of whether attainment has been achieved will not be made until collection and evaluation of monitoring data from the 2020 ozone season has been completed (VCAPCD 2017). Ozone concentrations in Ventura County exceeded the eight-hour O_3 standard on only seven days in 2019, which is the lowest recorded number of exceedances since the federal eight-hour O_3 standard was lowered to 0.070 parts per million in 2015 (VCAPCD 2020).

In addition, continued implementation of Senate Bill (SB) 743, while aimed at addressing transportation impact analyses under the California Environmental Quality Act (CEQA), provides opportunities for air quality co-benefits. Section 15064.3 was added to the State CEQA Guidelines requiring transportation impact analysis be based on vehicle miles travelled (VMT), instead of a congestion metric (such as Level of Service) and stating that a project's effect on automobile delay shall not constitute a significant environmental impact, as previously required. Reductions in VMT equate to reductions in mobile emissions of criteria pollutants and TACs, providing local and regional air quality benefits over time. Despite advances in air quality improvement, however, an increased frequency and intensity in wildfires continues to adversely affect local and regional air quality.

Existing Conditions

Climate and Meteorology

Climate and meteorology directly influence local and regional air quality. Ventura is in the South Central Coast Air Basin (SCCAB), which includes all of San Luis Obispo, Santa Barbara, and Ventura counties. The climate of the SCCAB is strongly influenced by its proximity to the Pacific Ocean and the location of the semi-permanent high-pressure cell in the northeastern Pacific known as the Pacific High. The Mediterranean climate of Ventura produces moderate average temperatures although extreme temperatures can be reached in the winter and summer. Rainfall is concentrated in the winter months. The warmest month of the year is September, and the coldest month of the year is January (National Weather Service 2020). The annual average mean temperature is 60.4 degrees Fahrenheit (°F) with annual average rainfall of 14.4 inches.

During the day, the predominant wind direction is from the west and southwest, and at night, wind direction is from the north and generally follows the Santa Clara River Valley. The SCCAB is subject to

seasonal Santa Ana winds. Santa Ana winds are strong north to northeasterly winds that originate from high-pressure areas centered over the desert of the Great Basin. These winds are usually warm, dry, northerly winds which blow offshore at 15 to 20 miles per hour (mph) but can reach speeds in excess of 60 mph. Two types of temperature inversions (warmer air on top of cooler air) are created in the SCCAB: subsidence and radiational. Both types of inversions limit the dispersal of air pollutants within the regional airshed because more stable air conditions (i.e., low wind speeds and uniform temperatures) result in lower rates of pollutant dispersion.

Air Pollutants of Primary Concern

Toxic Air Contaminants

In addition to criteria air pollutants described above, toxic air contaminants (TACs) are air pollutants of primary concern. TACs are a diverse group of air pollutants that may cause or contribute to an increase in deaths or serious illness, or that may pose a present or potential hazard to human health. TACs include both organic and inorganic chemical substances that may be emitted from a variety of common sources, including gasoline stations, motor vehicles, dry cleaners, industrial operations, painting operations, and research and teaching facilities. One of the main sources of TACs in California is diesel engines that emit exhaust containing solid material known as diesel particulate matter (DPM). TACs are different than criteria pollutants because ambient air quality standards have not been established for TACs. TACs occurring at extremely low levels may still cause health effects, and it is typically difficult to identify levels of exposure that do not produce adverse health effects. TAC impacts are described by carcinogenic risk, and by chronic (i.e., long duration) and acute (i.e., severe but of short duration) adverse effects on human health. In 2005, the California Air Resources Board released the Air Quality and Land Use Handbook: A Community Health Perspective, which identified major sources of TACs in communities and provided advisory recommendations for siting distances between sources of TACs and sensitive receptors. In the city, high volume roadways like U.S. 101 and State Route 126 are local sources of TACs.

Odor

Land uses most often associated with odor complaints include agricultural uses, wastewater treatment plants, food processing plants, chemical plants, composting, refineries, landfills, dairies, and fiberglass molding. Local sources of nuisance odors include operation of nearby agricultural lands and wastewater treatment plants.

Air Pollution Sources

The primary sources of air pollution in Ventura County are on-road and off-road mobile sources, which generate approximately 45 percent of daily ROG emissions and approximately 90 percent of daily NO_X emissions (CARB 2016). On-road mobile sources include passenger cars, medium- and heavy-duty trucks, buses, motorcycles, and other vehicles operating on highways, freeways, and local roads. Off-road mobile sources include aircraft; locomotives; commercial and recreational marine vessels operating within three miles of shore; agricultural, construction, and lawn and garden equipment; off-road recreation vehicles; and a wide variety of other equipment. Other air pollution sources in Ventura County include stationary sources (e.g., fuel combustion, waste disposal, cleaning and surface coatings, petroleum production and marketing, and industrial processes) and areawide sources (e.g., solvent evaporation and miscellaneous processes). Table 3 shows the annual average daily emissions inventories for ROG, NO_X, CO, SO_X, PM_{10}, and $PM_{2.5}$ for Ventura County and Figure 1 breaks out

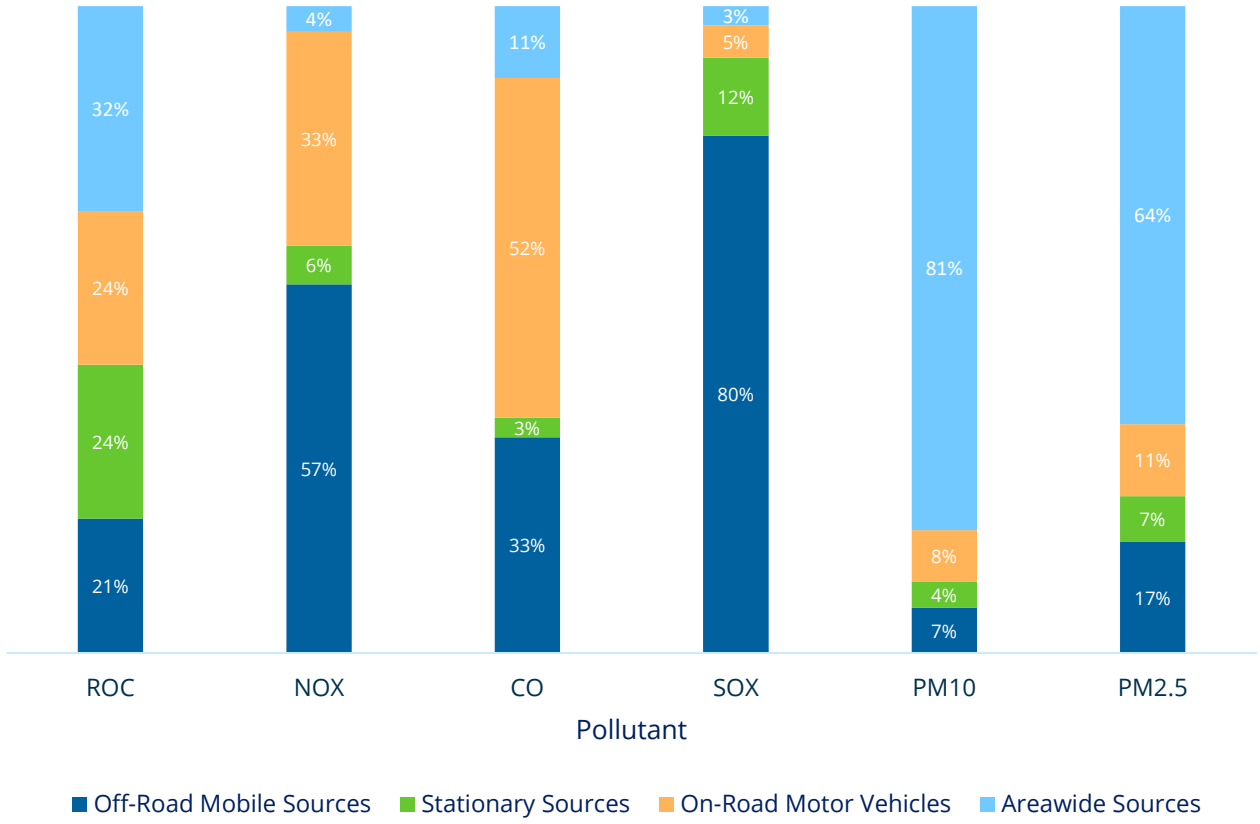
emissions inventories by source (CARB 2016).[4] In Ventura, the major local air pollution sources are on-road vehicles, particularly those traveling on U.S. 101 and State Route 126, as well as industrial land uses and agricultural land uses within and adjacent to the city.

Table 2: Ventura County 2012 Estimated Annual Average Daily Emissions

Pollutant	Tons per day
ROG	35.8
NO_X	130.17
CO	41.24
SO_X	1.93
PM_{10}	16.44
$PM_{2.5}$	5.85
Sources: CARB 2016	

[4] The year 2012 is the most recent year for which baseline air emissions data is available. Emissions inventories do not include marine emissions (those emissions within three miles of the shoreline generated by sources such as ocean-going vessels, commercial harborcraft, recreational boats, aircraft, and cargo handling equipment) or outer continental shelf air basin marine emissions (those emissions beyond three miles of the shoreline generated by sources such as oil and gas production, aircraft, ships and commercial boats, ocean-going vessels, and commercial harborcraft) because these emissions occur in the State Tidelines region and the Outer Continental Shelf Air Basin, which are evaluated separated by VCAPCD.

Figure 1: Ventura County 2012 Estimated Annual Average Daily Emissions by Source



Sources: CARB 2016.

Ambient Air Quality

The air quality monitoring stations nearest to Ventura are the Ventura-Emma Wood State Beach and the El Rio-Rio Mesa School #2 monitoring stations located at Emma Wood State Beach and Rio Mesa High School, respectively. The data collected at these stations is generally representative of the baseline air quality experienced in Ventura. Due to its proximity and coastal location, the Ventura-Emma Wood State Beach monitoring station provides the most representative ambient air quality data. However, data from this station is only available from 1996 to 2011 for O_3 and from 1996 to 2004 for NO_2. Therefore, ambient air quality data for the remaining years and pollutants is sourced from the El Rio-Rio Mesa School #2 station. Table 4 summarizes the annual air quality data from 1996 to 2019. As shown therein, the number of days of exceedances of federal and state air quality standards has generally remained the same or decreased over the last 23 years for all pollutants with the exception of PM_{10}, which was exceeded the State standard more frequently from 2016 to 2018 than from 1996 to 2015. The increased number of exceedances in 2017 and 2018 were likely due to particulate matter mobilized by recent wildfires, including the Thomas Fire, which burned approximately 280,000 acres in Ventura and Santa Barbara counties in 2017, and the Woolsey Fire, which burned approximately 97,000 acres south of Ventura in Ventura and Los Angeles counties in 2018.

Table 3: Ambient Air Quality Data in Vicinity of Ventura – Number of Days of Exceedances of Federal and State Air Quality Standards

Year	Federal/ State 8-Hour O_3 Standard	Federal Worst-Hour O_3 Standard	State Worst-Hour O_3 Standard	Federal NO_2 Standard	State NO_2 Standard	Federal SO_2 Standard[3]	State SO_2 Standard[3]	Federal/ State CO Standard[3]	Federal PM_{10} Standard	State PM_{10} Standard	Federal $PM_{2.5}$ Standard[4]
1996	26	1	10	0	0	0	0	0	0	1	n/a
1997	7	0	2	0	0	0	0	0	1	3	n/a
1998	4	0	0	0	0	0	0	0	0	2	n/a
1999	1	0	0	0	0	0	0	0	0	0	1
2000	1	0	0	0	0	0	0	0	0	1	2
2001	6	0	0	0	0	0	0	0	0	3	2
2002	0	0	0	0	0	0	0	0	0	2	0
2003	10	0	0	0	0	0	0	0	0	5	2
2004	3	0	0	0	0	0	0	0	0	1	0
2005	2	0	0	0	0	n/a	n/a	n/a	0	2	0
2006	0	0	0	0	0	n/a	n/a	n/a	0	4	0
2007	1	0	0	0	0	n/a	n/a	n/a	1	2	1
2008	1	0	0	0	0	n/a	n/a	n/a	0	3	0
2009	0	0	0	0	0	n/a	n/a	n/a	0	2	0
2010	0	0	0	0	0	n/a	n/a	n/a	0	1	0
2011	0	0	0	0	0	n/a	n/a	n/a	0	1	0
2012	0	0	0	0	0	n/a	n/a	n/a	0	1	0
2013	0	0	0	0	0	n/a	n/a	n/a	0	4	0

2014	2	0	1	0	0	n/a	n/a	n/a	0	7	0
2015	0	0	0	0	0	n/a	n/a	n/a	0	6	0
2016	1	0	0	0	0	n/a	n/a	n/a	0	14	0
2017	1	0	0	0	0	n/a	n/a	n/a	1	29	4
2018[5]	0	0	0	0	0	n/a	n/a	n/a	2	21	1

Notes:

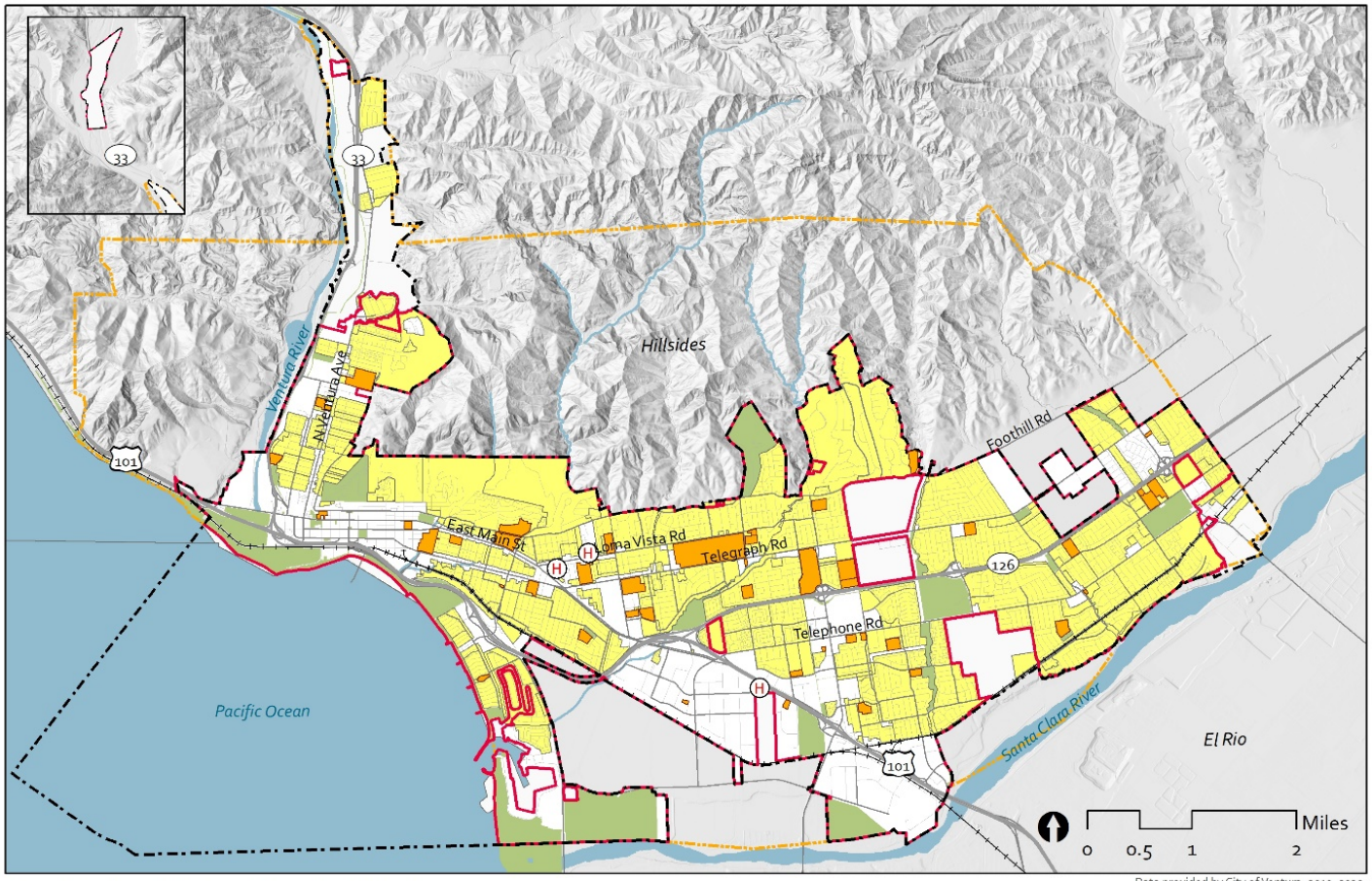
1. O_3 data from 1996-2011 and NO_2 data from 1996-2004 were sourced from the Ventura-Emma Wood State Beach monitoring station. O_3 data from 2011-2018, NO_2 data from 2004-2019, PM_{10} data from 1996-2018, and $PM_{2.5}$ data from 1999-2018 were sourced from the El Rio-Rio Mesa School #2 monitoring station.
2. The number of days of exceedances are based on current federal and state air quality standards, some of which have evolved and become more stringent between 1996 and 2018. For example, in 1997, the U.S. EPA replaced the former federal 1-hour O_3 standard with an 8-hour O_3 standard of 0.08 ppm. The U.S. EPA reduced the federal 8-hour O_3 standard to 0.075 ppm in 2008 and again to 0.070 ppm in 2015 (U.S. EPA 2019b).
3. SO_2 and CO data are not available at any monitoring station in Ventura County from 2005 to 2018.
4. $PM_{2.5}$ data is not available at any monitoring station in Ventura County from 1996 to 1998.
5. At the time of publication, air quality data was not available for 2019.

Sources: CARB 2020

Sensitive Receptors

Ambient air quality standards have been established to represent the levels of air quality considered sufficient, with an adequate margin of safety, to protect public health and welfare. Standards are designed to protect that segment of the public most susceptible to respiratory distress, such as children under 14; the elderly over 65; persons engaged in strenuous work or exercise; and people with cardiovascular and chronic respiratory diseases. Therefore, the majority of sensitive receptor locations in Ventura are residences, schools, hospitals, and parks.

Figure 2: Air Pollutant Sensitive Receptors



Issues and Opportunities

The following list identifies issues and opportunities related to air quality that can be addressed in the General Plan update:

- Several residential areas in the City are adjacent to U.S. 101 and SR 126. These high-volume roadways can generate substantial quantities of air pollution, including toxic air contaminants. The current General Plan requires siting of sensitive uses to consider health risk from adjacent industrially designated areas (Action 7.23) but does not include policies or processes with respect to future siting or to address the potential intensification of sensitive uses near highways or other sources of TACs. The updated General Plan should establish policies and processes to address land use compatibility as uses change, intensify and/or expand. These policies could include establishing any residential intensification away from high volume roadways and establishing policies or processes to require health risk assessments or standardize air filtration requirements for projects that would site sensitive uses within specific buffer distances of high-volume roadways and other sources of TACs.
- The current General Plan requires payment of fees to fund regional transportation demand management programs for projects that generate emissions above VCAPCD recommended thresholds (Action 7.22). The City may wish to consider expanding this policy to include funding and development of VMT mitigation strategies, as local and regional programs to reduce VMT are established.

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Appendix A – Criteria Pollutants

Ozone

Ozone is produced by a photochemical reaction (triggered by sunlight) between NO_X and ROC. NO_X is formed during the combustion of fuels, while ROCs are formed during combustion and evaporation of organic solvents. Because O_3 requires sunlight to form, it mostly occurs in substantial concentrations between the months of April and October. Ozone is a pungent, colorless, toxic gas with direct health effects on humans including respiratory and eye irritation and possible changes in lung functions (VCAPCD 2003). Groups most sensitive to O_3 include children, the elderly, people with respiratory disorders, and people who exercise strenuously outdoors.

Carbon Monoxide

CO is a local pollutant that is found in high concentrations only near its sources. The primary source of CO, a colorless, odorless, poisonous gas, is automobile traffic. Elevated concentrations, therefore, are usually only found near areas of high traffic volumes. Other sources include fuel combustion equipment. The health effects of CO are related to its affinity for hemoglobin in the blood. At high concentrations, CO reduces the amount of oxygen in the blood, causing heart difficulty in people with chronic diseases, nausea, reduced lung capacity, and impaired mental abilities (VCAPCD 2003).

Nitrogen Dioxide

NO_2 is a by-product of fuel combustion, with the primary source being motor vehicles and industrial boilers and furnaces. The principal form of nitrogen oxide produced by combustion is nitric oxide (NO), but NO reacts rapidly to form NO_2, creating the mixture of NO and NO_2 commonly called NO_X. Nitrogen dioxide is an acute irritant. Elevated levels of NO_2 can cause respiratory irritation, impaired pulmonary function, and bronchitis (VCAPCD 2003). NO_2 absorbs blue light, gives a reddish-brown cast to the atmosphere, and reduces visibility. It can also contribute to the formation of ozone, smog and acid rain.

Suspended Particulates

Atmospheric particulate matter is comprised of finely divided solids and liquids such as dust, soot, aerosols, fumes, and mists. The particulates that are of particular concern are PM_{10} and $PM_{2.5}$. The characteristics, sources, and potential health effects associated with the PM_{10} and $PM_{2.5}$ can be different. Major man-made sources of PM_{10} are agricultural operations, industrial processes, combustion of fossil fuels, construction, demolition operations, and mobilization of road dust into the atmosphere. Natural

sources include windblown dust, wildfire smoke, and sea spray salt. Elevated levels of PM_{10} can cause respiratory irritation, reduced lung function, aggravation of cardiovascular disease, and cancer (VCAPCD 2003). The finer $PM_{2.5}$ particulates are generally associated with combustion processes and formation in the atmosphere as a secondary pollutant through chemical reactions. $PM_{2.5}$ is more likely to penetrate deeply into the lungs and poses a serious health threat to all groups, but particularly to the elderly, children, and those with respiratory problems. Elevated levels of $PM_{2.5}$ can cause respiratory stress and decreased lung function and increase the risk of long-term disease (VCAPCD 2003). More than half of the small and fine particulate matter that is inhaled into the lungs remains there, which can cause permanent lung damage. These materials can damage health by interfering with the body's mechanisms for clearing the respiratory tract or by acting as carriers of an absorbed toxic substance.

Sulfur Dioxide

SO_2 is a colorless, pungent, irritating gas formed primarily by the combustion of sulfur-containing fossil fuels. When SO_2 oxidizes in the atmosphere, it forms sulfur trioxide (SO_3). Collectively, these pollutants are referred to as sulfur oxides (SO_X). In humid atmospheres, SO_2 can also form sulfuric acid mist, which can eventually react to produce sulfate particulates that can inhibit visibility. Combustion of high sulfur-content fuels is the major source, while chemical plants, sulfur recovery plants, and metal processing are minor contributors. At sufficiently high concentrations, SO_2 irritates the upper respiratory tract. At lower concentrations, when in conjunction with particulates, SO_2 appears to do still greater harm by injuring lung tissues. This compound also constricts the breathing passages, especially in people with asthma and people involved in moderate to heavy exercise. Sulfur dioxide causes respiratory irritation, including wheezing, shortness of breath, and coughing (VCAPCD 2003). Long-term SO_2 exposure has been associated with increased risk of mortality from respiratory or cardiovascular disease. Sulfur oxides, in combination with moisture and oxygen, can yellow leaves on plants, dissolve marble, and eat away iron and steel.

Lead

Lead (Pb) is a metal found naturally in the environment, as well as in manufacturing products. Lead occurs in the atmosphere as particulate matter. The major sources of Pb emissions historically have been mobile and industrial sources. As a result of the United States Environmental Protection Agency's (U.S. EPA) regulatory efforts to remove Pb from gasoline, atmospheric Pb concentrations have declined substantially over the past several decades. The most dramatic reductions in Pb emissions occurred prior to 1990 due to the removal of Pb from gasoline sold for most highway vehicles. Lead emissions were further reduced substantially between 1990 and 2008, with reductions occurring in the metals industries in part due to national emissions standards for hazardous air pollutants (U.S. EPA 2013). As a result of phasing out leaded gasoline, metal processing is currently the primary source of Pb emissions. The highest level of Pb in the air is generally found near lead smelters. Other stationary sources include waste incinerators, utilities, and lead-acid battery manufacturers. Lead may cause a range of health effects, including anemia, kidney disease, and neuromuscular and neurological dysfunction (in severe cases) (U.S. EPA 2019a).